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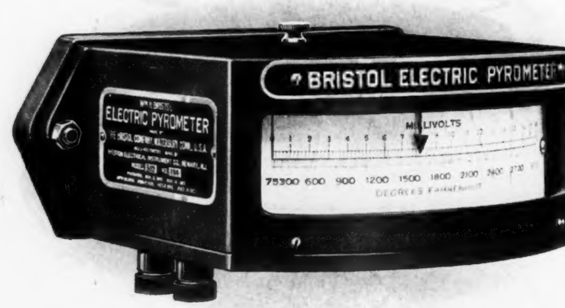

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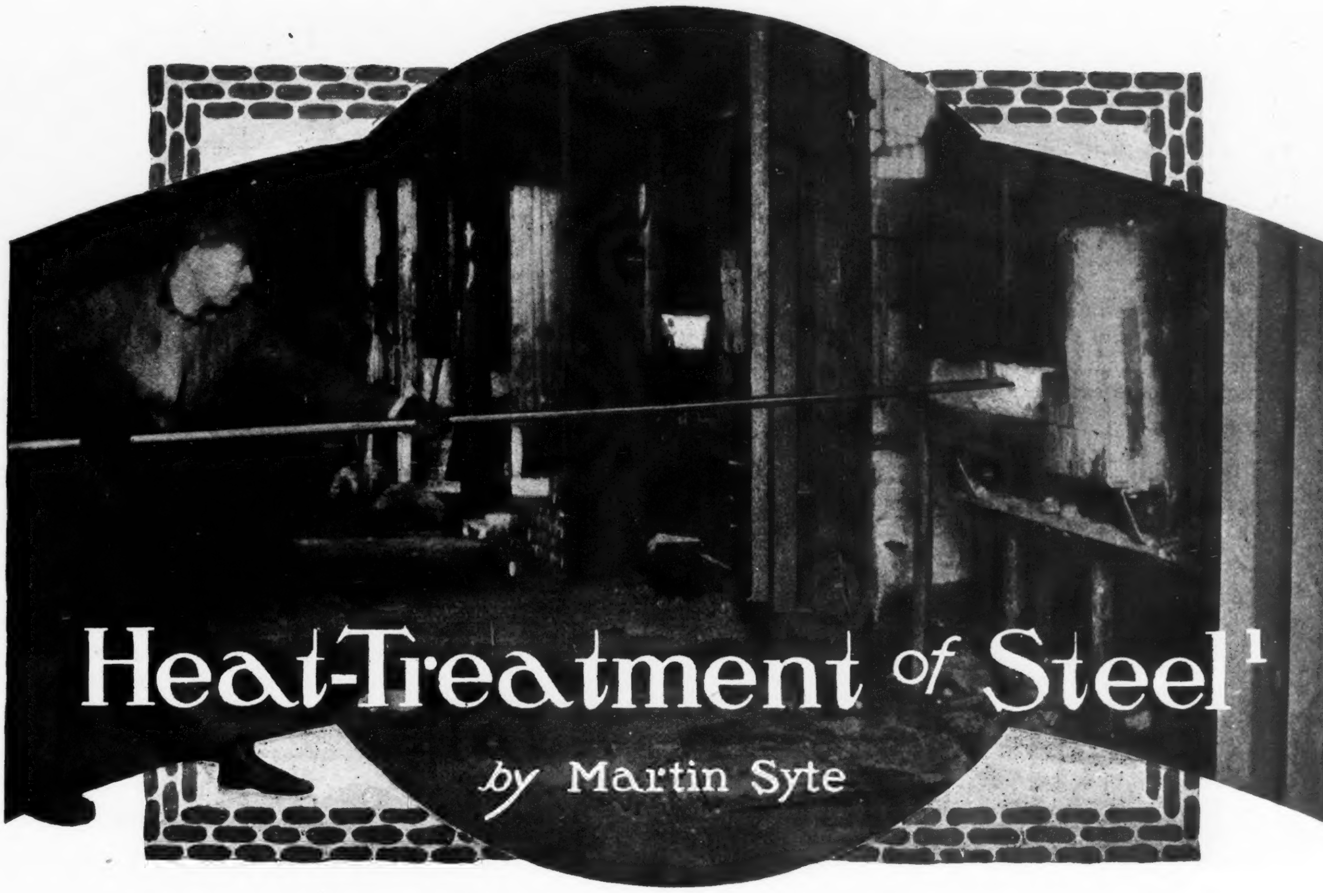


Heat-Treatment of Steel[1]

by Martin Syte

This article is the first installment of an elementary treatise on steel and the changes wrought by heat-treatment. Much has been published on the heat-treatment of steel which presupposes considerable technical knowledge on the part of the readers; the importance of the subject makes it desirable that knowledge of means and methods for improving the physical characteristics of the common material of mechanical construction be more widely spread and generally understood.

CARBON steel is an alloy composed chiefly of iron and carbon, but contains also manganese, sulphur, phosphorus and silicon. In alloy steels, one or more of the following elements are found: chromium, nickel, vanadium, tungsten, molybdenum, etc. We can therefore readily see that carbon steel may be a very complex alloy. While the two constituents which are really responsible for its distinguishing characteristics are iron and carbon, each of the remaining elements contributes to the properties of this alloy. In some cases they are valuable, and in other cases they exert a harmful effect, but owing to the difficulty of entirely removing them on a commercial scale, they are allowed to remain in the metal, provided they do not exceed certain well established limits. In alloy steels, such as nickel-chrome and chrome-vanadium steel, valuable properties are obtained by the addition of these elements.

There are today many metallic alloys which are valuable both from a commercial and a scientific standpoint, and many of them possess properties that are exactly contrary to what might be anticipated. For instance, the alloying of a hard and a soft metal may result not in one of intermediate hardness, but of greater or sometimes less hardness than either of its constituents. Again, in most alloys the melting point is lower than the mean melting point of all its constituents; but in the case of an alloy of 78.4 per cent gold and 21.6 per cent aluminum it is higher. While steel is the most valuable alloy commercially and has therefore been the subject of constant investigation, there still remain many points which are not thoroughly understood.

For instance, why is it possible to take a bar of this alloy and by giving it what is termed an annealing treatment, put it in such a state that it will have a tensile strength of 90,000 pounds per square inch, together with marked ductility and considerable softness? Also, why is it possible to take this same bar and by heating it to a certain temperature and plunging it into oil, change its properties entirely? It may now possess a tensile strength of 270,000 pounds per square inch, or three times the former figure, practically no ductility and extreme hardness. What has taken place? If this process were not done every day on a large commercial scale, we would call it magic. We have taken a bar of this metal and by subjecting it to a gradual temperature change and then a sudden change of temperature in the opposite direction, have increased its strength three times. From a chemical standpoint, the alloy is still steel, containing all the ingredients that it had before we gave it this treatment. What changes in structure have taken place to produce such marked changes in its properties?

Thirty years ago we had very few means at hand to investigate the changes taking place under heat-treatment, but today we have the metallurgical microscope and the thermo-electric pyrometer. By the former we are enabled to examine the structure of the steel minutely, and by the latter we can measure very small quantities of heat and obtain an accurate record of the heat-treatment to which steel is subjected. As we shall refer to the use of these two instruments frequently, it will be well to give a brief description of their design and principles of operation. The metallurgical microscope differs from ordinary microscopes in that opaque specimens are used instead of transparent specimens mounted on glass, and this requires a special means of lighting. Any microscope to which has been added an attachment for illuminating opaque specimens may be used as a metallurgical microscope, but the types

[1] For other articles on the heat-treatment of steel published in MACHINERY, see "Roll Hardening," June, 1916; "The Heat-treatment of Drop-forging Dies," February, 1916; "Method of Local Hardening," February, 1916; "Carburization and Heat-treatment," September, 1915, and other articles there referred to.

built especially for this purpose are, of course, much more convenient to use and give better results. Fig. 2 shows how light is utilized to illuminate the specimen.

It will be observed that the light ray, coming from whatever source of light is used, enters through a hole in the microscope tube and strikes a transparent glass disk *A* which reflects the light downward onto the polished and etched surface of specimen *B*, from which it is, in turn, reflected back through disk *A* and up to the eye of the observer. In place of the glass disk, a small mirror may be used or a prism, but the glass disk has found general favor. Several sources of illumination may be used with a suitable set of condensing lenses to regulate the beam of light. Welsbach burners, Nernst lamps, acetylene burners and electric arc lamps each have their advocates. When it is desired to take a photomicrograph of the specimen, a camera attachment is connected to the microscope. Fig. 1 shows a complete outfit with microscope, source of light and camera attachment connected.

The specimen to be examined must be polished by a series of operations with finer and finer abrasives until a mirror-like

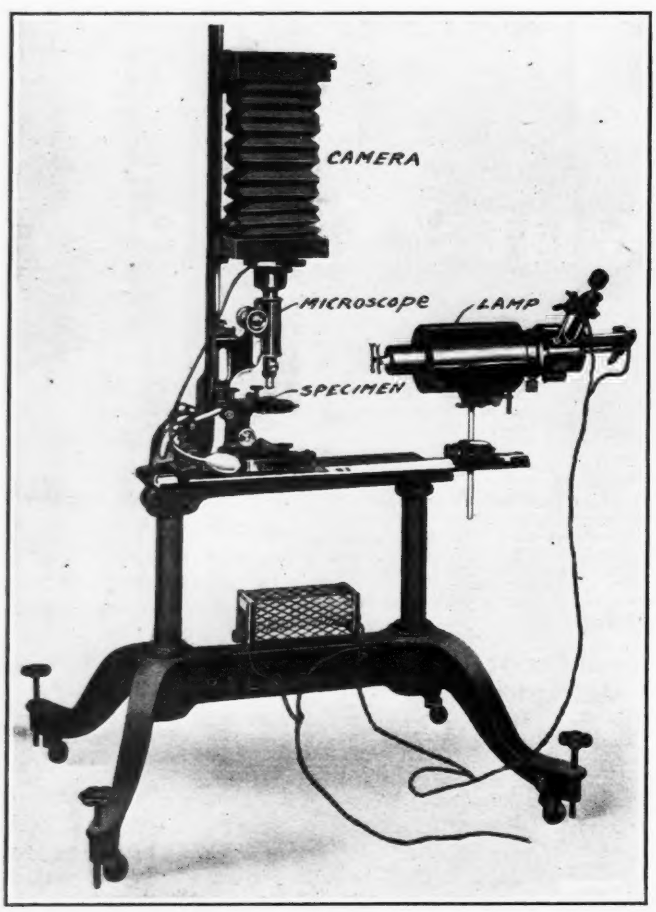


Fig. 1. Metallurgical Microscope with Camera for taking Photomicrographs

finish is obtained. Successive grades of emery paper may be used for the preliminary steps after the specimen has first been roughed down with an emery wheel or file. To obtain the final polish, use is made of rouge or fine levigated alumina suspended in distilled water and applied to a revolving disk covered with a cloth. Still quicker results may be obtained by polishing with the various power polishing outfits on the market. After the specimen has been polished, it is etched by dipping it into acid for a few moments, and then washed in alcohol and dried. This brings out the structure of the metal. A 5 per cent solution of picric acid in absolute alcohol and a 10 per cent solution of nitric acid in absolute alcohol are quite commonly used for etching steel specimens.

The thermo-electric pyrometer is an instrument for measuring temperatures. It makes use of the well-known principle that when two wires—each composed of a different metal or metallic alloy—are joined together and the junction is heated, an electromotive force is set up. The higher the temperature the greater is the electromotive force generated. Therefore, by measuring this force, we can tell the temperature to which the junction of the pyrometer is heated. Fig. 3 shows a section of a pyrometer, one wire of which is composed of pure platinum and the other of an alloy containing 90 per cent platinum and 10 per cent rhodium. The ends of the wire which are joined compose what is called the "hot junction," and this is the end placed in the furnace; the other ends of the wire, called the "cold junction," are connected to a milli-voltmeter to measure the number of millivolts generated by the pyrometer. However, instead of being graduated in milli-volts only, there is also a scale showing the temperature that corresponds to each fraction of a milli-volt.

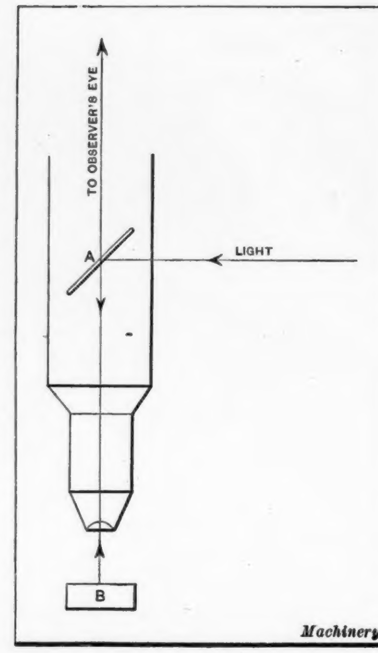


Fig. 2. Diagram showing how Light is utilized to illuminate Opaque Specimens examined under Metallurgical Microscope

Some pyrometers, instead of having wires of noble metal, such as gold, silver, platinum, rhodium, iridium, etc., have wires made of base metals, such as iron, nickel, chromium, etc. They are not as accurate or durable as the noble-metal wire pyrometers, but they are stronger and much cheaper, and for most commercial operations possess sufficient accuracy. They cannot be used, however, at the high temperatures that the noble metals withstand effectively, namely, up to about 3000 degrees F. As pyrometers are usually calibrated when the cold junction is at a temperature of 0 degrees C. (32 degrees F.), it is necessary to make certain corrections in the temperature they record when this junction is at any other temperature. The makers supply formulas for doing this, and in some cases they have designed automatic devices for this purpose. When the correction must be calculated, it is essential to keep all the cold junctions at the same temperature; otherwise, there will be a different correction for each pyrometer. Not only this, but the cold junction of the pyrometer must also be kept at a constant temperature; otherwise, there will be a different correction as the temperature of the junction varies. Owing to the low cost of pyrometers with base-metal couples, it is often practical to run wire leads of the same material as the pyrometer wire itself directly to the milli-voltmeter, and if this is done with each pyrometer, the cold junction would then be at the milli-voltmeter and would be at the same temperature for all pyrometers. Each system of noble or base-metal couples has its advantages, and only a thorough study of existing conditions will suffice to make a proper choice for any given service.

Returning now to the piece of steel we have been considering, let us examine it under the microscope just as it comes from the mill. It will appear as shown in Fig. 4. This photomicrograph has enlarged the view 200 diameters. Let us bear in mind that this represents the micro-structure of this particular steel when it is in such a state that it possesses a tensile strength of 90,000 pounds per square inch. Let us now heat the piece of steel to a temperature of 840 degrees C. (1544 degrees F.), hold it at this tem-

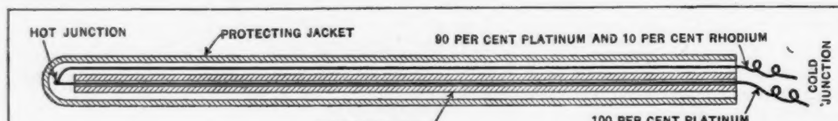


Fig. 3. Sectional View of Thermo-electric Pyrometer with Platinum, Platinum-rhodium Couple

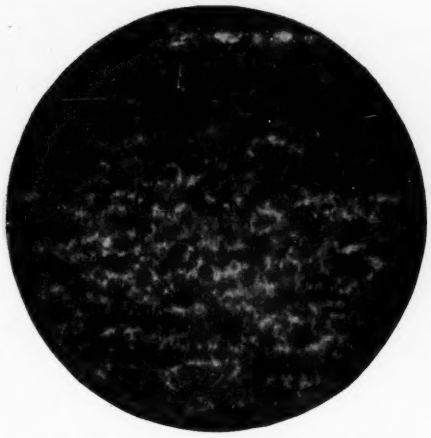


Fig. 4. Photomicrograph of Steel in Condition in which it leaves Mill—Magnification, 200 Diameters

Fig. 5. Photomicrograph of Steel after being quenched at 1544 Degrees F.—Magnification, 200 Diameters

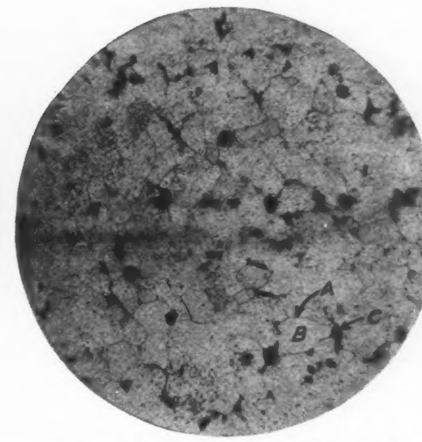


Fig. 6. Photomicrograph of 0.10 Per Cent Carbon Steel after being "normalized"—Magnification, 65 Diameters

perature for ten minutes and then quench it in oil. It now has a tensile strength of 270,000 pounds per square inch. Under the microscope it will appear as shown in Fig. 5, from which we note that there is a great change in structure from that shown in Fig. 4, and undoubtedly this is directly connected with the change in physical properties. But while we can readily see this change, we are at a loss to understand or to really appreciate it. What are the dark spots and what are the light ones in Fig. 4? In order to know this we must start in an elementary way and build up our facts little by little.

Steel may contain variable proportions of carbon, from a very small amount, such as 0.05 per cent, up to as high as 2.20 per cent. In order, therefore, to cover the subject completely, it will be necessary to study samples containing different amounts of carbon between the limits stated. Let us first procure, therefore, several samples of 0.10 per cent carbon steel from different sources. When we examine this steel under the microscope, we will probably note that some of the samples present an entirely different appearance from others. In some, dark grains may be seen clearly defined on a white background, while in others there may be a more blended effect so that nothing is sharply defined, either as to outline or color. This is due to the fact that these pieces, coming from different sources and receiving different degrees of temperature in the treatment they were last subjected to, have had imparted to them correspondingly different structures. In order, therefore, to study all the samples we are to investigate, let us give them a uniform heat-treatment, imparting to them all a clearly defined structure in which we may be better able to distinguish one constituent from another. This treatment has been called "normalizing" and consists of heating the specimen to about 1000 degrees C. (1832 degrees F.) and then cooling it very slowly. If we do this to all our 0.10 per cent carbon specimens, we will find that they all present about the same structure as in Fig. 6. There will, of course, be a difference in texture in the different specimens and also in different parts of the same specimen, but Fig. 6 represents a characteristic structure, shown at a magnification of sixty-five diameters.

Fig. 7. Photomicrograph of Specimen shown in Fig. 6, but with Magnification of 650 Diameters

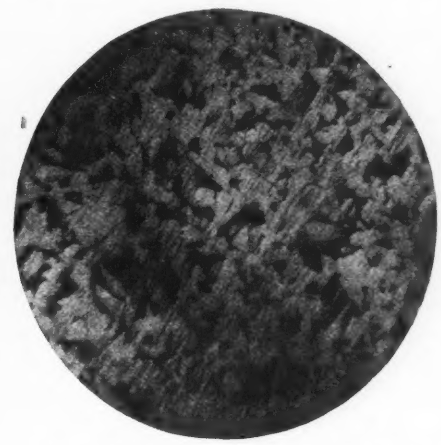


Fig. 8. Photomicrograph of 0.30 Per Cent Carbon Steel showing Increase in Pearlite—Magnification, 65 Diameters

Now, if we examine Fig. 6, we note that it shows a dark network *A* surrounding white grains *B*, and that, in addition, there are some dark grains *C*. This network will not always appear unless the metal has been etched considerably, but it always exists, as it constitutes the boundaries of the white grains. These white grains are composed principally of iron,

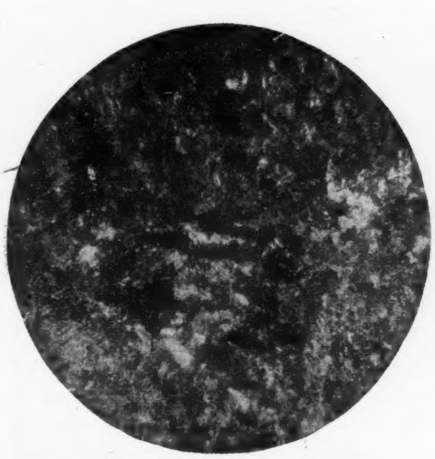


Fig. 9. Photomicrograph of 0.90 Per Cent Carbon Steel showing almost Unbroken Pearlite—Magnification, 65 Diameters

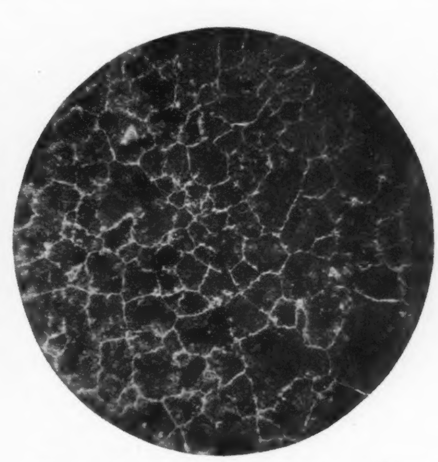


Fig. 10. Steel with 1.5 Per Cent Carbon, showing Network of Cementite around Pearlite—Magnification, 65 Diameters

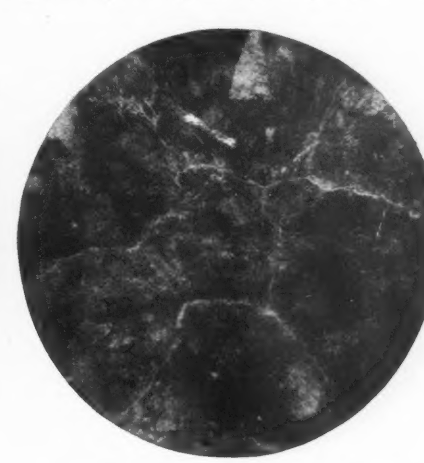


Fig. 11. Photomicrograph of Same Steel shown in Fig. 10, but with Magnification of 260 Diameters

although they may contain some impurities or alloying elements, but we will consider them iron. They are called "ferrite" grains; and the dark grains are called "pearlite." If we enlarge further, we will see that, instead of being composed only of dark matter, the pearlite grains consist of some lighter matter and generally present an appearance somewhat like that shown in Fig. 7. This is because they are composed of alternate plates of ferrite and of a constituent called "cementite."

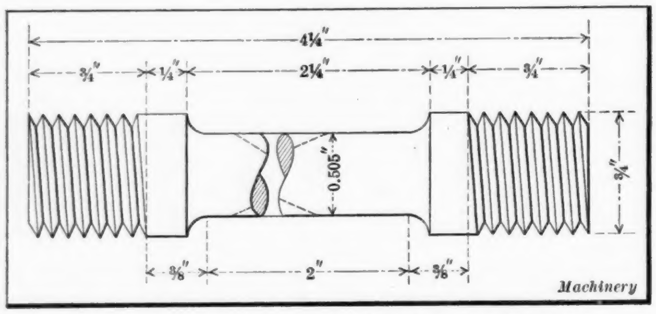


Fig. 12. Steel Specimen prepared for making Tensile Tests

We would naturally think that the white plates were ferrite, because this substance appears white in the grains of ferrite *B*, Fig. 6; but this is not the case, because the cementite plates are very hard and stand out in relief in the light, while the ferrite, being softer, is worn away by the polishing process so that it is below the level of the cementite plates, and hence is not so brightly illuminated. An additional reason for its darker appearance is the fact that it is more readily attacked by the etching acid than are the cementite plates. Cementite is carbide of iron, with the chemical formula Fe_3C. It is, therefore, a definite chemical compound. Ferrite may be considered as iron and has the formula Fe. Pearlite is not a chemical compound, but is a mechanical mixture composed of alternate plates of iron or ferrite (Fe) and carbide of iron or cementite (Fe_3C). In certain lights pearlite has the same appearance as mother of pearl and derives its name from this similarity.

We have noted in the foregoing the most important points in the structure of a normalized piece of 0.10 per cent carbon steel. Let us now see if we can make some use of this knowledge and anticipate the structural appearance of a specimen of 0.30 per cent carbon steel. As all the carbon is contained in the cementite plates, we would naturally infer that there would be three times as many of these plates in the 0.30 per cent carbon steel as in 0.10 per cent carbon steel. Now, as all the cementite is mixed mechanically with alternate plates of ferrite to form pearlite, we would also infer that there would be three times as much pearlite in the 0.30 per cent carbon steel. Fig. 8 is a photomicrograph of such a steel, and this shows that our assumption is correct, as there is about three times as much of the dark material—pearlite—as there is in Fig. 6.

If we examine steels of higher carbon content, we will observe more carbon-bearing (pearlite) grains, until at a content of about 0.90 per cent carbon, we note that practically the whole piece is composed of pearlite. (See Fig. 9.) If we examine a steel higher in carbon, say 1.50 per cent, we would naturally expect to find it composed mostly of pearlite, but what has happened to the extra carbon in excess of 0.90 per cent? Examination shows that it combines with the iron, forming carbide of iron, Fe_3C, which occurs as a network around the grains of pearlite. In other words, the piece is composed practically of pearlite with the exception of a network of cementite or carbide of iron. (See Figs. 10 and 11.) As the carbon increases, this network increases slightly.

We have now investigated enough specimens to form an idea of the appearance of the micro-structure of normalized steels of various carbon contents. Let us bear in mind that we do not always encounter steel in the normalized state, but that we have changed all our specimens to this state, so we can have a common ground for comparison and also because in this state, as already mentioned, we can easily distinguish the carbon-bearing grains from the iron grains. Let us now summarize the facts:

1. The micro-structure of low-carbon normalized steel shows a background of light ferrite grains interspersed around their boundaries and junctions with a few dark pearlite grains.

2. If we enlarge these pearlite grains, we note that they are composed of alternate plates of ferrite (iron) and cementite (carbide of iron).

3. As we examine pieces of higher and higher carbon content, we note that the only pronounced difference in appearance

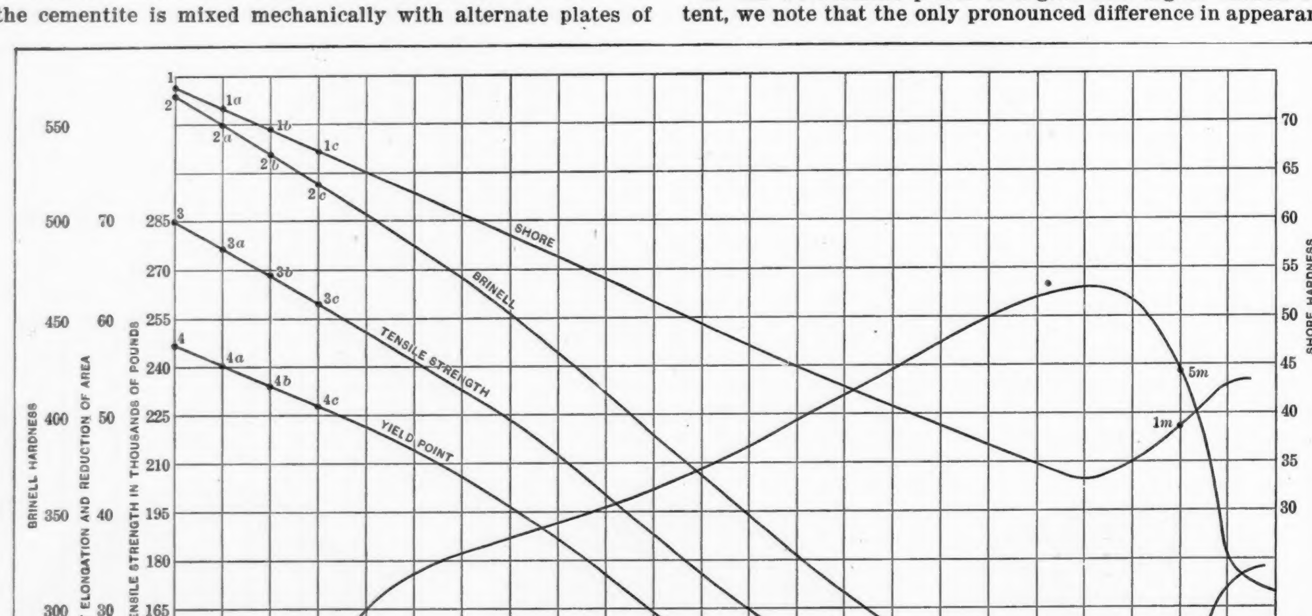


Fig. 13. Chart showing Changes in Physical Properties of Steel produced by drawing at Different Temperatures

is in the increase of the amount of pearlite until finally, when we reach a steel of about 0.90 per cent carbon, it exhibits all pearlite. If we further increase the carbon, a white network of cementite in excess of that required to take part in the formation of pearlite is shown around the pearlite grains.

We have, therefore, noted the micro-structure of normalized steels, so that it will now be of interest to learn something about their physical properties. Before doing so, however, it will be best to describe what the physical properties of metals are and just how and with what instruments we measure them.

Physical Properties of Steel

The physical properties of steel in which we are particularly interested are: first, tensile strength; second, elastic limit; third, ductility; and fourth, hardness. To test a specimen of steel for the first three properties mentioned, a sample is taken—preferably in the standard form shown in Fig. 12—and placed in a testing machine. The thread on the upper end of the sample fits into a holder which is connected with a system of weighing levers such as are found in a weighing scale. The lower end of the specimen fits into another holder, which may be driven up or down by means of a motor and gears. By starting this motor, the piece is slowly subjected to a gradually increasing load, which may always be determined by keeping the scale beam balanced by moving the counterbalance weight along it.

Testing Proportional Limit

Let us now place a piece in the machine and balance the scale beam at zero, after which the motor is started and the piece subjected to a gradually increasing load. Now, as this load is increased the steel sample stretches in proportion to the load. For instance, if a load of 2000 pounds causes it to stretch 1/64 inch, a load of 4000 pounds will cause it to stretch 1/32 inch. This continues until a point is reached in the loading of the piece where an increase in load of 2000 pounds, for instance, instead of producing an elongation of 1/64 inch, produces, say, half as much again, or 3/128 inch. In other words, we have arrived at a point where the elongation is not proportional to the load. This point is therefore called the "proportional limit."

Testing Yield Point

The increase in the elongation or stretching of the piece becomes more and more pronounced until we arrive at a point where the piece keeps on stretching, even when no further load is applied. This point is called the "yield point." In practice it is often determined by the "drop" of the beam on the testing machine; it is frequently confused with the elastic limit, and often considered as such by those who are not fully informed. The true elastic limit occurs a little after we have passed the "proportional limit." It may be located accurately by the fact that after the elastic limit is passed, if the entire load is released the piece will not return to its original length, but will have suffered a permanent "set" or lengthening. At any point prior to the elastic limit the piece would have returned to its original length when the load was entirely removed. We therefore can readily understand the definition of elastic limit, which is given as the least load per square inch that produces a permanent set.

Returning now to our testing of the piece, we continue to load it after the yield point has been reached and the piece continues stretching as the load is applied until we reach the maximum load that the piece will stand. When this point is reached, if we endeavor to add a larger load, we will find that the piece will not support it, but will stretch and "neck in"; and if we continue this loading, the piece will finally break. The instrument used to determine the amount of stretching and set, and thus to locate the elastic limit, is called an extensometer, and is attached directly to the specimen.

After the specimen is broken it will generally appear as shown by the dotted lines in Fig. 12. If, before testing, we had placed two slight punch-marks on it we could, by fitting the ends together, determine how much the piece had stretched; and by measuring the diameter of the decreased section, we could determine how much the cross-sectional area had been reduced. For instance, let us figure out the properties of a specimen, the dimensions of which before testing were the same as shown in Fig. 12; elongation after testing, ½ inch; diameter of reduced section, 0.300 inch; load on piece at yield point, 15,000 pounds; maximum load on piece, 20,000 pounds.

The cross-sectional area of the piece before testing was 1/5, or 0.200 square inch. Hence, if a piece 1/5 square inch in area withstood a load of 20,000 pounds, the estimated strength of a piece five times that area, or one square inch, would be 5 × 20,000 pounds, or 100,000 pounds per square inch; and it would possess a yield point of 5 × 15,000 pounds, or 75,000 pounds per square inch. As the area before testing was 0.200 square inch, and the diameter after testing had been reduced to 0.300 inch, which corresponds to an area of 0.071 square inch, the specimen had its area reduced from 0.200 square inch to 0.071 square inch, or a reduction of area of 65 per cent. As the piece elongated ½ inch in 2 inches, it elongated ¼ inch in 1 inch, or an elongation of 25 per cent. Hence the test gave the following physical properties: Tensile strength, 100,000 pounds per square inch; yield point, 75,000 pounds per square inch; reduction of area, 65 per cent; elongation, 25 per cent. The last two properties, reduction of area and elongation, are, in reality, a measure of the ductility of the piece.

Testing Hardness of Metals

The remaining property we have to consider is hardness. There are several instruments designed for testing the hardness of metals, but we will discuss only those most commonly used, namely, the Shore scleroscope and the Brinell hardness tester. The former instrument consists chiefly of a glass tube with suitable means for leveling vertically, and a small tap or hammer with a diamond point embedded in its lower end. By means of a bulb and cylinder arrangement, this hammer may be sucked up to the upper end of the glass tube and allowed to drop on the smooth, flat surface of the metal under test; then by noting the height to which the hammer rebounds on a scale provided for that purpose, a measure of the hardness is obtained. In the Brinell machine the chief parts are a hydraulic press and a hardened steel ball, which is generally 10 millimeters in diameter. This ball, by means of the hydraulic press, operated by a small hand pump, is driven into the steel with a certain specified load. The softer the steel, the farther the ball sinks in; and the harder the steel, the less it sinks in. By measuring the exact amount that the ball sinks in, or, more easily, the diameter of the impression left by it in the steel under test, which is generally done by means of a small microscope, we may obtain a measure of the hardness of the steel.

With this information at hand, let us consider the results we would obtain if we tested the normalized steels previously discussed. We would note that the lower carbon samples would have a lower tensile strength, yield point and hardness than those of higher carbon content. Their elongation and reduction of area, however, would be greater, *i. e.*, they would be weaker but more ductile. This is due to the fact that ferrite has a tensile strength estimated at about 50,000 pounds per square inch and pearlite 125,000 pounds per square inch. Consequently, the higher carbon steels have more strength due to the larger amount of this stronger constituent which they contain. When we have a steel that contains all pearlite, *i. e.*, a eutectoid steel, we would have a strength of 125,000 pounds per square inch in the normalized state. Higher carbon steels than this would contain a network of cementite and would be no stronger, as this constituent is hard and brittle, and possesses a tensile strength of possibly only 5000 pounds per square inch. By observing the physical properties of a eutectoid steel which is all pearlite, and of a very low-carbon steel which is practically all ferrite, we can get a good comparative idea of the properties of these two constituents.

Effects of Heat-treatment

We have confined ourselves so far principally to normalized steels. Let us now take up the important consideration of heat-treated steels. Before we go into the theory involved,

let us first endeavor to understand clearly the practical results obtained by heat-treatment. It will be impossible to describe these results in detail for several different analyses of steel; but we can take one steel and study it in detail, and this will teach us what we can expect from other steels. Let us, therefore, consider a steel with 0.50 per cent carbon. The various properties it has under heat-treatment are shown graphically in Fig. 13, which gives the average results of over 20,000 tests on this particular steel. A chart of this nature may not be readily understood at first glance, but a little study will make it clear, and it will then be retained in the memory much more easily than the long written description which would be required without it. By interpreting this chart correctly, many facts can be ascertained and the proper treatment to obtain a given result may be found from it. In order to understand the chart thoroughly we must know how it was obtained, and this we will now consider.

All samples of this steel were first hardened with great care and uniformity at the correct hardening temperature. How this temperature was ascertained will be described later. In this case the temperature was 832 degrees C. (1530 degrees F.), and this was maintained as closely as possible; after heating, the pieces were quenched in oil. After receiving this treatment, all samples were very hard and brittle, and possessed a high tensile strength. Owing to their extreme brittleness, it was impracticable to get a good test of them, so that a few were drawn at a temperature of 204 degrees C. (400 degrees F.) and then tested. The physical properties determined in this test were then marked down on the chart at points 1, 2, 3, 4, 5, 6, directly above the 204 degrees C. (400 degrees F.) drawing temperature. We note that the tensile strength was 285,000 pounds per square inch, yield point 246,000 pounds per square inch, elongation 2.5 per cent, reduction of area 6.5 per cent, Brinell hardness 565, and Shore hardness 74.

Let us now take another lot of samples of this steel which we have just hardened and draw them at a temperature of 232 degrees C. (450 degrees F.). We note that the tensile strength is 276,000 pounds per square inch, yield point 241,000 pounds per square inch, elongation 2.5 per cent, reduction of area 11 per cent, Brinell hardness 550, and Shore hardness 72 (see points 1*a*, 2*a*, 3*a*, 4*a*, 5*a*, and 6*a*). It is therefore apparent that drawing the steel at this higher temperature has caused it to lose in tensile strength, yield point and hardness, but to gain in ductility, *i. e.*, amount of elongation and reduction of area. By taking additional lots of samples which have been hardened and drawing them at higher temperatures, we obtain the points 1*b*, 2*b*, 3*b*, 4*b*, 5*b*, 6*b*, 1*c* . . . 6*c*, etc. For instance, by drawing the hardened pieces at 482 degrees C. (900 degrees F.), the tensile strength has dropped to 187,000 pounds per square inch, yield point to 164,000 pounds per square inch, Brinell hardness to 390, Shore hardness to 52, and the reduction of area and elongation have increased to 42.5 and 7.5 per cent, respectively.

We therefore note that if a steel is merely hardened, it possesses its maximum tensile strength, yield point and hardness, and its minimum ductility. Now, if we draw this hardened steel, it loses in tensile strength, yield point and hardness, but gains in ductility. If we draw our samples at still higher temperatures, we will finally pass beyond the temperature to which the term "draw" applies. In other words, we will begin to draw at such a temperature that the piece has a visible color, and we eventually arrive at an "annealing" temperature. We note that the lowest tensile properties and greatest ductility were obtained by drawing the steel at about 738 degrees C. (1360 degrees F.). Comparing the properties at this point on the chart with those at 400 degrees F., we obtain the following results:

	Hardened at 832 Degrees C. (1530 Degrees F.) Drawn at 204 Degrees C. (400 Degrees F.)	Hardened at 832 Degrees C. (1530 Degrees F.) Drawn (Annealed) at 738 Degrees C. (1360 Degrees F.)
Tensile strength....	285,000 lbs. per sq. in.	100,000 lbs. per sq. in.
Yield point.........	246,000 lbs. per sq. in.	75,000 lbs. per sq. in.
Reduction of area..	6½ per cent	63 per cent
Elongation	2½ per cent	19 per cent
Brinell hardness...	565	228
Shore hardness.....	74	33

The preceding comparison shows what a remarkable change in the properties of steel can be wrought by heat-treatment. The tensile strength was increased or decreased, as desired, from 100,000 to 285,000 pounds per square inch, and the other properties almost in like measure. The question might here arise as to whether by drawing the steel at a still higher temperature, say 788 degrees C. (1450 degrees F.), we would not still further reduce the tensile properties and increase the ductility. In drawing the steel it was heated to the desired temperature for one hour and then cooled in the air. If we should draw at a temperature much above 1360 degrees F. and then cool in the air, the steel would "air harden," because we have heated it above its first critical point, as will be more fully explained later. In this case the tensile strength would be increased and the ductility decreased, as is shown on the chart at points 1*m*, 2*m*, 3*m*, 4*m*, 5*m*, and 6*m*. In other words, as we draw this steel from 204 degrees C. (400 degrees F.) to successively higher temperatures, we get a definite and constant change in its properties, but as soon as we draw at a temperature much above 1360 degrees F. we get a complete reversal of these changes.

From this chart we can tell just about what properties we may expect from a given hardening and drawing treatment of this steel, or we may tell just what treatment will be required to obtain a given set of properties. For instance, if the steel is hardened at 832 degrees C. (1530 degrees F.) and drawn at 443 degrees C. (830 degrees F.), we will obtain a tensile strength of 204,000 pounds per square inch, yield point of 179,000 pounds per square inch, elongation of 6.5 per cent, and reduction of area of 40 per cent. If, on the other hand, we want to use this steel for an application where we must have a reduction of area of at least 15 per cent and want to know what the other properties would be and what heat-treatment to give the steel, we look on the chart and note the point where the reduction of area curve rises to 15 per cent and see that this point is directly over a drawing temperature of 254 degrees C. (490 degrees F.), that the tensile strength would therefore be 270,000 pounds per square inch, the yield point 235,000 pounds per square inch, and elongation 3 per cent.

If we should want to treat this steel so it would have a Shore hardness of 71 and a reduction of area of 40 per cent, we will find that drawing at 238 degrees C. (460 degrees F.) would give the hardness desired, but the reduction of area would be only 12 per cent. In consequence, the steel would not answer the purpose desired. This leads to the important consideration that it is often impossible to fulfill every requirement desired in a steel, and we must therefore compromise and get the nearest combination of properties which will answer our purpose. This is due to the fact that hardness and strength are obtained at the expense of elongation and reduction of area. The chart shows this very clearly, and in a manner which can be easily memorized, as the tensile strength, yield point, and Shore and Brinell hardness curves all slope downward from left to right (except beyond the 1360-degree F. mark), while the reduction of area curve and elongation curve slope upward.

The question might arise in regard to charts of this nature, as to why the hardening temperature is not varied like the drawing temperature. The main reason for this is that every steel has but one correct hardening temperature, while it has any number of drawing temperatures, according to the application. It must be borne in mind that the chart gives the results for the particular steel chosen, and that it would not give accurate results for any steel. It does, however, show the general trend in the properties of all the ordinary steels after hardening and drawing. In lower carbon steel the hardness and strength would be lower and the ductility greater; and in still higher carbon steels the opposite would be the case.

* * *

At the autumn meeting of the British Iron and Steel Institute, Sir Robert Hadfield advocated the admission of women as associate members on the ground that women were now filling a most important part in the industrial life of the nation.

ERECTING AND STARTING A NEW ENGINE LATHE

Through a desire to get a lathe or other machine tool working at the earliest possible moment, many points in the erecting and starting of the machine are frequently neglected or overlooked entirely. Yet it is the care with which this preliminary work is done that determines whether or not a machine will do satisfactory work. The first essential in all cases is a good foundation; unless this is provided, accuracy and smoothness of finished work cannot be obtained. This foundation should be thoroughly laid before the lathe is placed in position. The lathe should not be bolted to the floor nor should any grouting be run over the feet when the tool is being leveled. The holes in the legs are for the lag screws that secure the lathe to the skids when it is crated for shipment. Before a lathe is used, it should be carefully cleaned and leveled. Every particle of grit and dirt must be removed from all bearing surfaces and from all oil holes; should any remain in the latter, it may be carried into a journal by the oil. The following information is given in a bulletin issued by the Lodge & Shipley Machine Tool Co.:

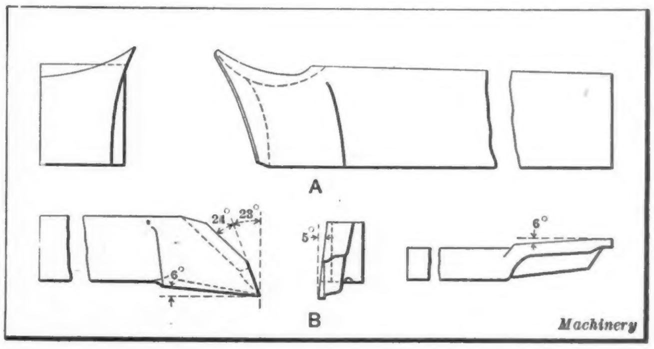
The slush compound that protects the finished surfaces of a lathe may be removed with benzine. The sliding tumbler gear under the headstock and the slip gear on the lead-screw should work easily. To clean and oil the dovetail surface of the bridge, the cross-slide guard or extension of the lower compound rest slide should be removed. This may be done by running the slide to the center of the carriage and then lifting off the guard. After the surface of the bridge is cleaned and oiled the guard should be replaced.

Unless a lathe is accurately leveled, it cannot do accurate work. No matter how stiff a bed may be it is not strong enough to prevent springing out of line when set on an uneven base. The level used for this purpose must be very sensitive and accurate; an ordinary carpenters' level will not do. After a lathe has been placed in position on its foundation, it should be leveled lengthwise; to do this, the level should be laid on the flat track lengthwise with the bed; that is, parallel with the track. When the lathe has been leveled in this direction, the carriage should be run close up to the headstock, the level placed upon a straightedge that rests on the front and rear arms of the carriage, and the bed carefully leveled by the head-end leg. The carriage should then be moved along and the bed leveled by each leg as the carriage rests over it. The position of the level across the wing should not be disturbed, and in the preliminary leveling the middle legs should be a trifle low rather than a little too high. As soon as the whole bed has been leveled, the carriage should be returned to the head-end and the operation repeated, to make sure that there is no wind.

A lathe that is not properly leveled will neither bore straight, face straight, nor turn straight; besides, it may chatter. Chattering may also be caused by the cutting edge of the tool being below the center of the work, by dirt getting between one of the centers and its bushing, and by the failure to clamp the tool securely in the toolpost. It is sometimes caused by end play in the spindle; this may be corrected by adjusting the collar and nut on the rear end of the spindle. When it is due to the loose fit of the cross-slide on the bridge the gib should be adjusted; if the compound rest gib is loose, this too should be adjusted. Chatter also occurs when all the feet are not solidly supported and when the work extends too far from the chuck. In the latter case the method of chucking should be changed or the outer end should be run in a steadyrest. In the case of a slender shaft, chattering may occur when there is too great a distance between the centers without support; in this case, also, a steadyrest should be used. The failure to use a steadyrest or follow-rest when a long piece is being turned between centers may result in poor work, as the piece is likely to spring away from the tool. An inaccurately fitted chuck plate will cause chattering. It is also produced by running at too high a speed for the class of work; by throwing the machine out of balance by the addition of special chucking fixtures; by the failure to bolt the chuck tightly against the chuck plate; and by work of an irregular shape or weight. If a tool-holder is used, the set-screw holding the inserted cutter should be tight.

When a lathe has been cleaned and set up, all the bearings should be flooded with oil. Only the best mineral oil should be used; animal oil has a tendency to clog the oil tubes in cold weather. The oil should be rich enough to lubricate the bearings, and should have sufficient body to last a reasonable length of time and withstand a cold test of 20 degrees. While there should be ample lubrication at all times, the bearings should be flooded with oil during the first few weeks of operation.

Should a lathe cut a drunken thread, the nut on the tailstock end of the lead-screw should be tightened, if loose. It should not be made too tight, however, or it will be difficult to get the sliding tumbler knob into the holes when the lathe is running. The lead-screw of a Lodge & Shipley lathe is always in tension, whether a right- or left-hand thread is being chased, because the pull is against the outer ends of the bearing in either case. Should it be necessary to remove any of the gears from the reverse plate, care must be taken, when they are being replaced, to locate them properly by dowel-pins.



A, Improperly Ground Tool; B, Good Form of Necking Tool

The cutting edge of a turning tool should be nearly straight, because the tool should work close to the shoulder and leave little metal for the necking tool to remove. Tools ground as shown at *A* in the accompanying illustration, though common, easily crumble and break. The finishing tool is of the same general design, but has a back slope of 8 degrees. For squaring and necking, an ordinary slender cutting-off tool is frequently used. The tool shown at *B*, however, is much superior.

When turning dry, the rake of a tool should not be as great as when a lubricant is used, because the cutting edge will then be too thin to carry away the heat. Tools for cast iron should be nearly flat on top. As a rule, with this metal, the coarser the feed the less is the chatter and the longer the tool will last. Tools for brass should be flat on top, or preferably should have a negative rake. For copper, bronze and aluminum the tools should be ground like those used for cutting steel.

When making cutting tools, the instructions for heat-treating any particular brand of steel should be carefully followed. In many up-to-date shops tools for cast iron, very hard iron, steel, cast steel, etc., are treated differently, although they may be of the same stock. Generally a tool will work better and stand up longer if it is ground down at least 1/32 inch after hardening. When grinding, a tool should not be pressed hard against the wheel.

As a rule, shafts should be rough-turned to within 0.015 or 0.02 inch above the finished size, rather than within 0.01 inch or less. The lathe operator can then use a coarse feed; besides, the greater range in size thus obtained eliminates the possibility of the grinding wheel failing to take out the tool marks. The coarser feed also makes the operation easier for the grinder, as the coarser the feed the easier it is on the wheel. In the case of shafts of small diameter, which are likely to spring when being roughed in the lathe, sufficient metal should be left to insure that the grinding wheel will true them up.

THREATENED DEARTH OF SKILLED WORKMEN

According to the New York *Times*, the greatest menace to American prosperity at the close of the war is not the possibility of the country being flooded with cheap foreign merchandise, but the great dearth of skilled and semi-skilled workmen that will exist. It said that makers of high-priced wares of the luxury class and other things that require considerable artistic or mechanical ability to produce are going to be hard put for several years, after peace is declared, to fill the benches when the present employes are gone. Most of the skilled labor in what might be called the arts' trades has for years come from Europe. But owing to the great burden of debt and taxation that will be placed on the people of the belligerent countries, an embargo will probably be placed on emigration, especially from those countries that have supplied the bulk of the workers for the artistic trades. As a result, the workers will be in a position to demand almost anything they want in the form of wages, hours of employment, etc. Precious metal workers cannot be made from anybody, and the supply of apprentices in this and other trades, both artistic and utilitarian, is lower than it has been for many years. In one of the best conducted jewelry shops, where the working conditions are ideal and the hours and pay are all that can be desired, there is not a single apprentice. The conditions are the same in the silk dyeing industry. This is work that requires considerable skill, for the dyer may do considerable monetary damage quickly if he is incapable or does his work in a slipshod way. Yet the younger men and boys seem to be avoiding the dye houses because they do not like the vapors, the odors, and the sloppiness of the work. Most of these workers are of foreign origin, possibly one or two generations removed, and many of them come from the countries that are most likely to restrict emigration after the war.

This dearth of men will also be felt in lines that do not require so high a degree of training and skill. It is no secret that England has offered all sort of inducements to American mechanics to go there and help in the manufacture of munitions. If American skill is needed in destroying much of Europe, it will be much more needed in restoring that which has been destroyed, and it is practically certain that the stricken nations will have to draw on the labor resources of other countries. Those who will go will be the unmarried men, the future labor strength of this country, and if they go, no one knows how many will come back or when.

Many reasons have been given for this dearth of skilled workmen. Most of them are based on the desire of the parents to have their children obtain more comfortable positions than they have filled or a disinclination of the children to follow the trade of their fathers. But the present lack of young workers and learners in many lines is partly due to the restrictions and rules imposed by the labor unions. Almost invariably the rules and regulations of the union specify the number of beginners or apprentices that may be employed in any given case, but wherever possible the number actually working is kept below the specifications. As an illustration of the manner in which the unions discourage the learning of the trades, there might be cited the case of the proprietor of a garment manufacturing house who wanted to teach his nephew the business from the bottom up so that the young man could take his place as soon as possible as an executive with a full understanding of the work that was being done in the place. He started his nephew at the most unskilled task of all, but soon afterward, deciding that he had learned all that was necessary of that work, moved him a step higher. The business agent of the union, however, held that the working agreement with the organization was being violated. He insisted that the other workers on the union list ahead of the nephew should be placed in the position first, and that if this were not done a strike would be called in the shop. This left the manufacturer just three things to do: he could take his nephew into the firm "green" and let him learn the business from the top down; he could let him learn it in his turn, in conformation with the union's rules, which might require years; or he could discharge him.

PRIMITIVE TOOLS

BY GUY H. GARDNER[1]

Some time ago there was found, among bone needles, flint axes and other relics of the long-forgotten races who inhabited Europe in prehistoric times, the object shown in Fig. 1. It is a stone 6 or 8 inches long by 1½ inch thick, having rounded

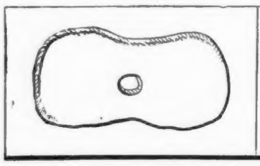


Fig. 1. Balance Wheel for Prehistoric Pump Drill

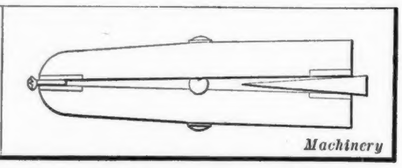


Fig. 2. Wooden Clamp for setting Gems in Rings

edges and a hole, about ½ inch in diameter, exactly through its center of gravity. Its use no one had been able to guess until a visitor to a jeweler's shop in the United States, idly turning over the leaves of a tool-dealer's catalogue, saw an illustration of the pump drill shown in Fig. 3. At once a possible solution of the puzzle came to him: it was a balance wheel for a prehistoric pump drill.

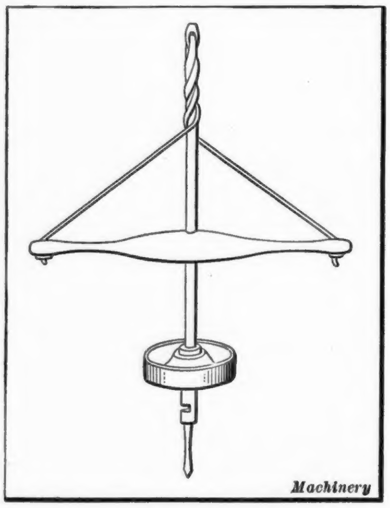


Fig. 3. Jewelers' Pump Drill

The writer cannot vouch for the accuracy of this conclusion, but it is easy to believe that the pump drill is very old. However, it was probably invented later than the fiddlebow, which was simply a cord wrapped about the drill shank and secured at its ends to a bent stick or the rib of an animal. The mechanics with whom these contrivances originated had, of course, no steel tools, but are supposed to have used as a drill a stick charged with sharp sand, the precursor of the modern lap. Though it may seem strange to many persons familiar with the tools and methods of modern shops, both of these drilling machines devised in the Stone Age are in use today.

A toolmaker, desiring to have a ring made, took a pearl and a number of gold coins to an old jeweler of high local repute and sat down to watch the process of manufacture. The casting presented no features of special interest, being done in an iron flask in which the mold had been made by using a brass pattern; but the method of making a seat for the pearl was a surprise. The ring was grasped in a clamp, Fig. 2, that was evidently a lineal descendant of the split stick used by our arboreal ancestors who felt the need of a hand vise. The fiddlebow arrangement shown in Fig. 4 was

[1]Address: New London, N. H.

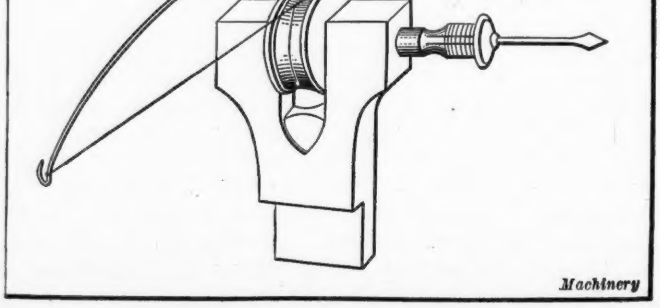


Fig. 4. Drilling Head operated by a Bow String

then put into the bench vise, the clamp held in the hand, and a hole made in the place where the pearl was to be. This hole was to guide the pearl drill, which might be called a two-lipped flat counterbore with a pilot teat. The fiddlebow drill was then taken from the vise and the clamp placed in it, after which the pearl drill, operated by the pump drill shown in Fig. 3, completed the seat. The subsequent operations on the ring were performed by methods quite similar to those anyone might use if called on to do the same work, though wholly unlike those of the manufacturing jeweler.

As the man had a fine lathe, the toolmaker asked why he used the primitive tools. The jeweler said that they gave him the "feel" of the cut, and enabled him to control the direction and the pressure more accurately than if he used the lathe. Whatever our ideas on this subject may be, the opinions of so excellent a mechanic as this man's work showed him to be must be respected. Besides, the fact that the tools are carried in stock by dealers and sold in considerable numbers indicates that he is not alone in the conviction of their superiority for certain classes of work.

Another tool of ancient origin, though much more modern than the drills and clamp just shown, is the lathe illustrated in Fig. 5. This lathe was in daily use in 1900, when a salesman for a firm of lathe manufacturers visited a European shop that was fairly well supplied with up-to-date tools and machines, but which had in one room twenty or thirty of these venerable relics. The superintendent explained that the fathers and grandfathers of the men had used such lathes, and it would be considered almost an act of sacrilege to displace them—a spirit of reverence for age which it would be hard to duplicate on this side of the Atlantic. The chuck used in these lathes, at least in some cases, is a block of wood having a cavity bored to hold the work, and made to grip it by moistening the wood. This device, by the way, is sometimes used by watchmakers when turning a bezel (the ring that holds the crystal) which they are afraid will be squeezed out of round by the jaws of the regular chuck.

As shown, this lathe is operated by pressing a pedal *A* that is connected, by a belt, to the small end of the cone pulley *B*.

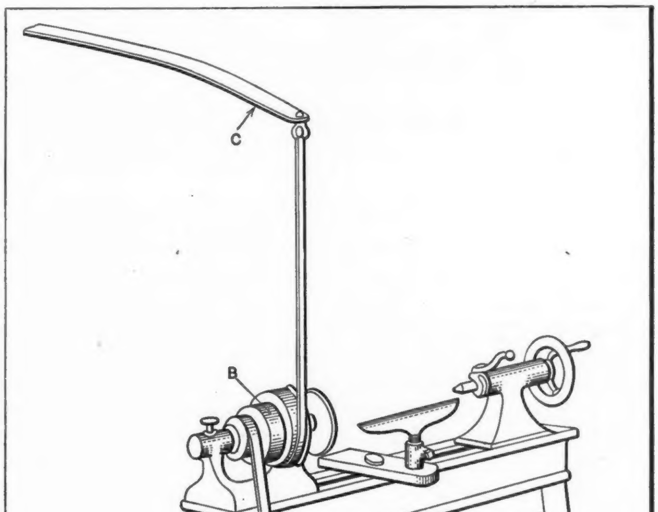


Fig. 5. Spring-pole Lathe

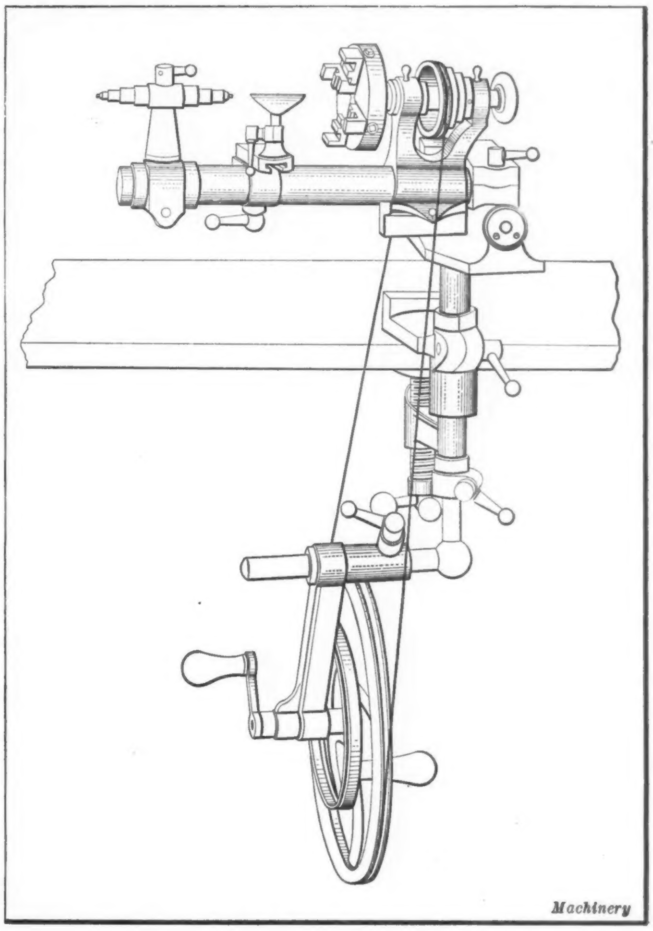


Fig. 6. Watchmakers' Lathe

The other end of this pulley is connected, by a belt, to a spring *C* fastened to the joists overhead. When the pedal is in the position shown, its belt is wrapped around the pulley several turns. So, as the pedal is pressed down, the belt is unwound and the pulley is made to rotate. This rotation winds up the belt connected with the spring. As this puts the spring under tension, as soon as the pressure of the foot is removed, the pulley is revolved in the opposite direction and winds up the belt attached to the pedal. Sometimes this spring is made of wood and a stirrup is used instead of the pedal.

Fig. 6 shows another machine which is strange to the American, but which is used by thousands of the finest workmen in the world. As shown, this watchmaker's lathe is fastened to the work-bench and run by a countershaft below. The operator turns this shaft with his right hand and guides the hand-tool or slide-rest with his left. Though clumsy in appearance and slow in operation, no better work is done anywhere than is turned out by the men who, after seven years' apprenticeship, earn their daily bread by "grinding" the hand crank.

* * *

LUBRICATION OF POPPET VALVE SUPERHEATED STEAM ENGINE

Some interesting data on lubrication of superheated steam engines have been furnished in terms of area swept by piston rings, and amount and cost of lubricating oil. The Thos. S. Watson Co., Milwaukee, Wis., reported that the cost of cylinder lubrication for a 20- by 32-inch Nordberg poppet valve engine at the plant of the Rockwell Mfg. Co. in Milwaukee is extremely low. The test covered a running time of 224.5 hours, during which period two gallons of cylinder oil, costing fifty-five cents a gallon, was used. The area of cylinder surface swept by piston rings per revolution is 27.92 square feet. The engine runs 150 revolutions per minute, and the surface swept over by the rings in an hour is 251,280 square feet; for the period of the test the area was 56,412,360 square feet, and 28,205,180 square feet per gallon of lubricating oil. The steam pressure was 150 pounds gage, superheated 120 degrees F., the average temperature being 480 degrees F.

MANUFACTURING PARTS OF TYPE 80 TIME FUSES[1]

MACHINING OPERATIONS ON TOP AND BOTTOM RINGS—DESIGN OF SPECIAL MACHINERY AND TOOLS

BY DONALD BAKER[2]

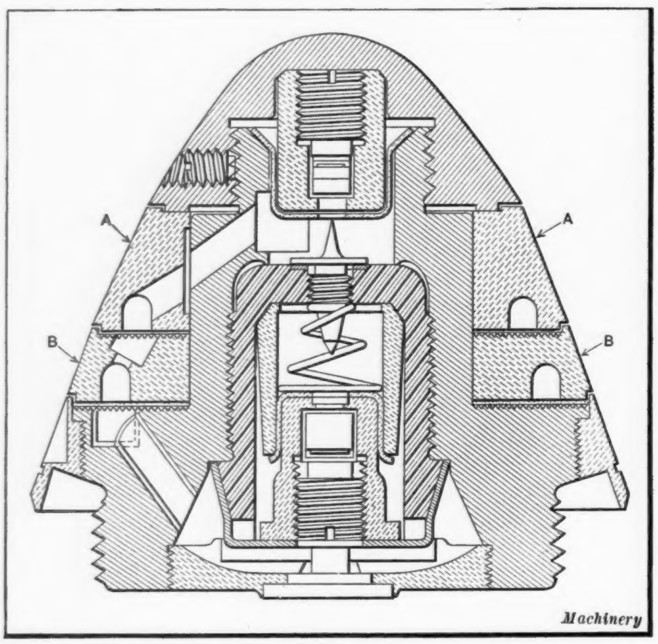


Fig. 1. Type 80 Time Fuse for which Upper and Lower Rings A and B are to be made

CONTRACTS for making many millions of types of time fuses, which have been placed in this country during the past two years, have led American manufacturers and mechanics to study the methods and machinery employed in this industry. There are many features of this work which are not encountered in other lines of manufacturing, and the difficulties experienced led many firms who took contracts to turn the work over to others who were better equipped or more successful in securing the desired results. It is the purpose of the present article to describe the manufacture of two parts of the Type 80 fuse, a cross-sectional view of which is shown in Fig. 1. The parts under consideration are the top ring *A* and the bottom ring *B*, which are shown in position in Fig. 1 and in detail in Figs. 2 and 3, respectively. These are the parts with which American fuse manufacturers have experienced the most difficulty. In the factory where the writer is employed these rings are formed under a punch press, the center hole is reamed, and one side faced, after which the work is placed on an expanding draw-in chuck to provide for turning the outside taper and cutting the groove in the face. After these operations, the work is sent to the shop in which all subsequent machining operations are performed.

[1] For other articles on fuse manufacture and allied subjects published in MACHINERY, see "Under-cutting Machine with Finger Guard," June, 1916; "Machine for Cutting Powder Train Grooves," May, 1916; "Making Cartridge Cases on Bulldozers and Planers," January, 1916; "High-explosive Shell Manufacture," December, 1915; "Metals Used in the Manufacture of War Munitions," November, 1915; "The Heat-treatment and Testing of Shrapnel Shells," September, 1915; "Shrapnel and Shrapnel Manufacture," April, 1915; and "Machining Shrapnel Shells," March, 1915.

[2] Address: Williams Mfg. Co., Ltd., Montreal, Canada.

Operation 1: Drilling Escape Hole.—The first machining operation consists of drilling the escape hole *A*, Fig. 3; and the accuracy obtained is a matter of particular importance, because the work is located from this hole for most of the following operations. The work is held in an ordinary latch jig similar to the one shown in Fig. 11, except that no locating pin is required.

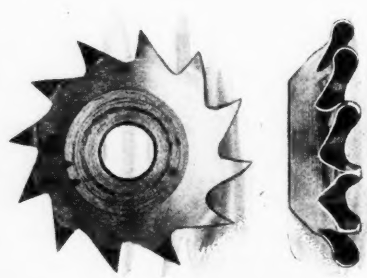


Fig. 4. Cutter for milling Powder Train Groove (Worn by Use)

Operation 2: Rough-milling Powder Train Groove.—It is the usual practice to mill the powder train groove *B*, Fig. 3, by one continuous cut, using a cutter of the end-mill type; but we found that the use of a circular cutter of the form shown in Fig. 4 made it possible to take a heavier cut at higher speed. About 0.005 inch is left on a side for finishing, and one roughing and one finishing machine have about four times the capacity of a single machine in which it is attempted to finish

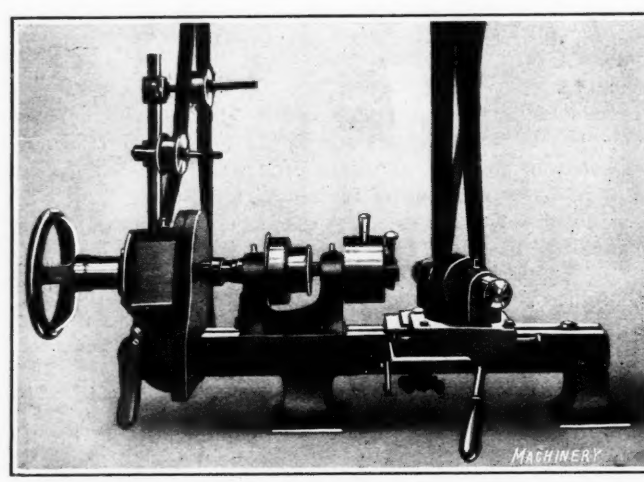


Fig. 5. Front View of Machine for roughing out Powder Train Groove

the groove by taking one cut with an end-mill. Figs. 5 and 6 show the machine used for this purpose, and Figs. 7 and 8 illustrate details of the design.

Referring first to Figs. 5 and 6, it will be noticed that the roughing machines are reconstructed bench lathes, having the usual bed and head but equipped with a special driving and feed mechanism, chuck and cutter-head, the latter being mounted on an adjustable slide. The feed mechanism is shown in detail in Fig. 7, and consists of spindle *A*, on the right-hand end of which there is a collar having two projecting pins which engage holes in a similar collar on the lathe spindle. This arrangement permits of the ready removal of the lathe head when it is in need of repair, without the necessity of disturbing the feeding mechanism. At *B* is shown a worm-gear which is a free running fit on the spindle, while at *C* there is a worm that is driven through a train of gears as illustrated in the lower left-hand corner of the illustration. Collar *D* has a number of holes drilled and reamed through it, which are tapped at one end to take the screws *E*, springs *F* and rawhide or fiber plugs *G*. This collar is pinned onto the spindle

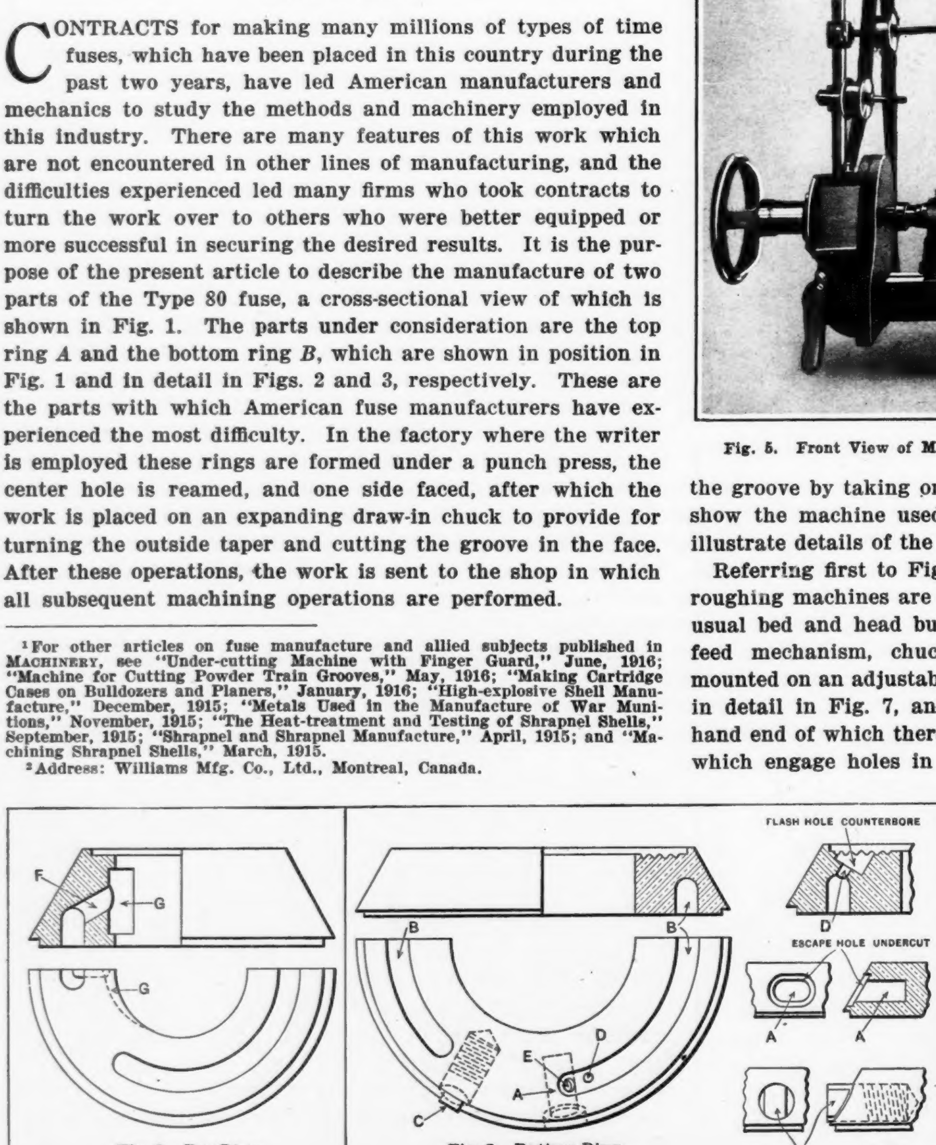


Fig. 2. Top Ring

Fig. 3. Bottom Ring

Figs. 2 and 3. Detail Views of Top and Bottom Rings shown in Position in Time Fuse in Fig. 1

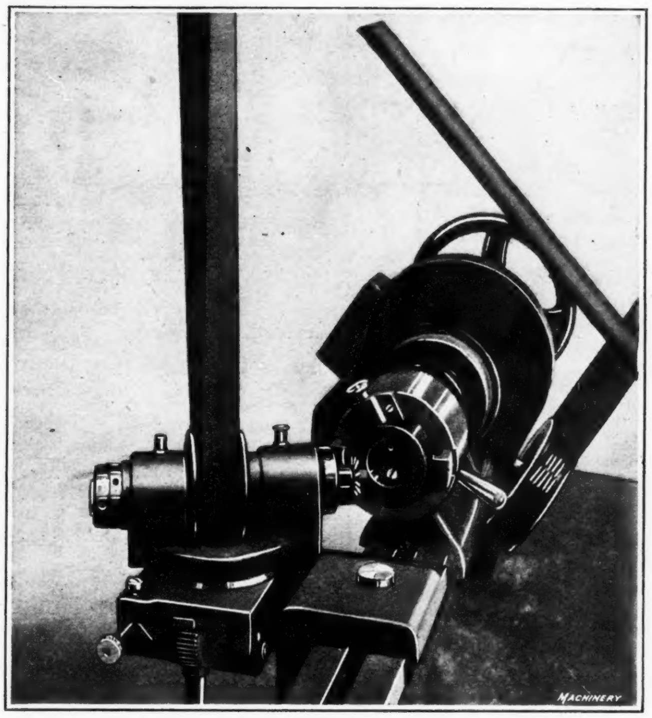


Fig. 6. End View of Machine shown in Fig. 5 for roughing out Powder Train Groove

and plungers G act as a friction on the side of the worm-gear; springs F are so adjusted as to give just the right amount of friction for driving the work against the cut, but not enough to strain the machine when index lever H drops into the slot in index plate J and brings the feed to an instant stop before the belt shifter has a chance to throw off the power entirely from worm C. The countershafts are of the usual bench lathe type which have shifters arranged to be worked by a wire leading down to a foot-treadle. Here, however, the wire is led

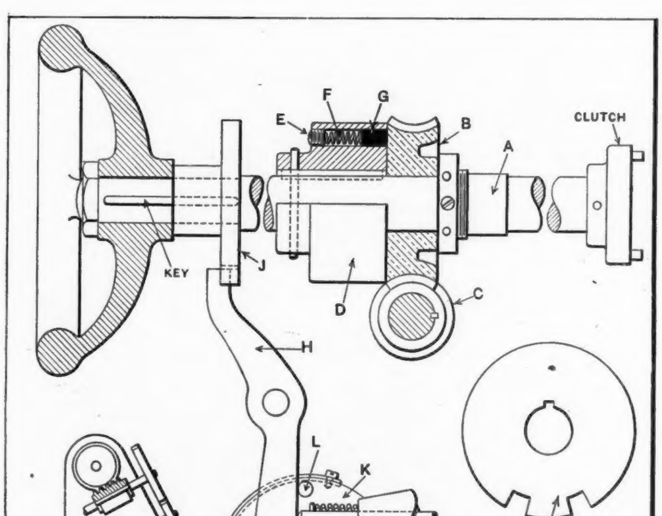


Fig. 7. Arrangement of Friction Feed Mechanism on Powder Train Groove Roughing Machine

down and up again over pulleys to sheave K, from which pin L projects and is held in contact with lever H so that motion of the lever back and forth rotates the sheave and shifts the belt accordingly. A better idea of the index plates will be given from the view shown at the right of the illustration, where the slots are shown which control the starting and stopping positions for regulating the length of the powder train groove.

Chuck for Roughing Machine

The type of chuck which is used to hold the rings on the roughing machines is shown in Fig. 8. This consists of a body A, outer sleeve B, locating nose of hardened steel, two jaws C, two slides D, coil springs E, shank F and handle G. The chuck as shown is closed; to open it handle G is thrown back in the direction indicated by the arrow, which rotates sleeve B that is threaded on the inside at one end and has two cam slots H cut in the other end. Rotating sleeve B causes chuck jaws C to be forced out, as their inner ends are threaded and engage with the threads on the sleeve. When the sleeve has been rotated far enough, the jaws are forced

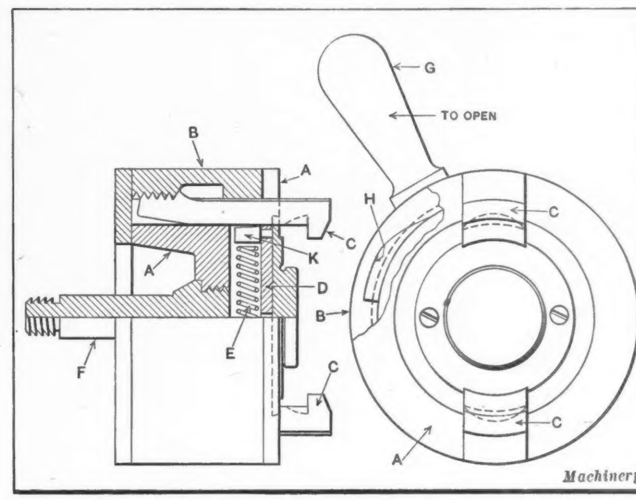


Fig. 8. Chuck in which Rings are held while roughing Powder Train Groove

back into cam slots H by the slides D, which are actuated by coil springs E acting against pins K that are riveted fast to the slides. Reversing the motion of handle G, first forces in the jaws and then draws them down onto the work, thus holding it securely for taking a heavy cut.

Operation of Roughing Machine

Fig. 6 shows an end view of one of the roughing machines in which a ring has just been placed and properly located by

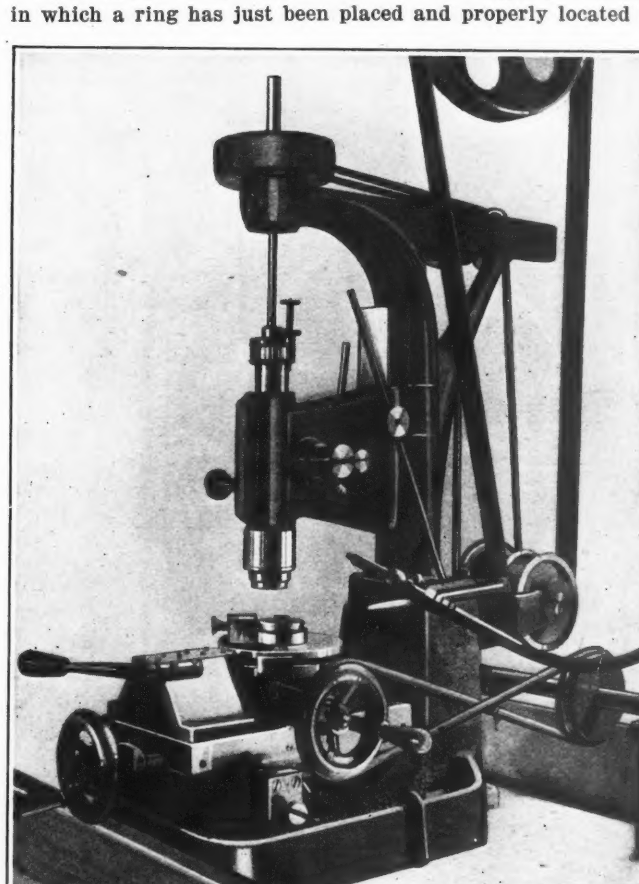


Fig. 9. Leland-Gifford Bench Drilling Machine with Special Equipment for finishing Powder Train Groove

the sliding pin which will be seen mounted on the top edge of the chuck. The jaws of the chuck are ready to be closed over the work by pulling the handle G forward. Referring to Fig. 5, the cutter is fed up and into the work by manipulating the hand-lever shown directly under the cutter-head; and when the cutter is in position, it is locked by means of a latch which can be seen hanging down from the left-hand end of the cutter-head slide, this latch being swung over the body of a shoulder screw in the end of the slide. Next, the feed is started by pulling out lever H, Fig. 7, which releases the index and at the same time throws on the belt. When the cut is finished, the end of this lever is automatically forced back into an index slot, thus stopping the machine at the right position. Then the finished ring is removed and the operations are repeated. The capacity of these roughing machines is between 1200 and 1400 rings in a ten-hour working day.

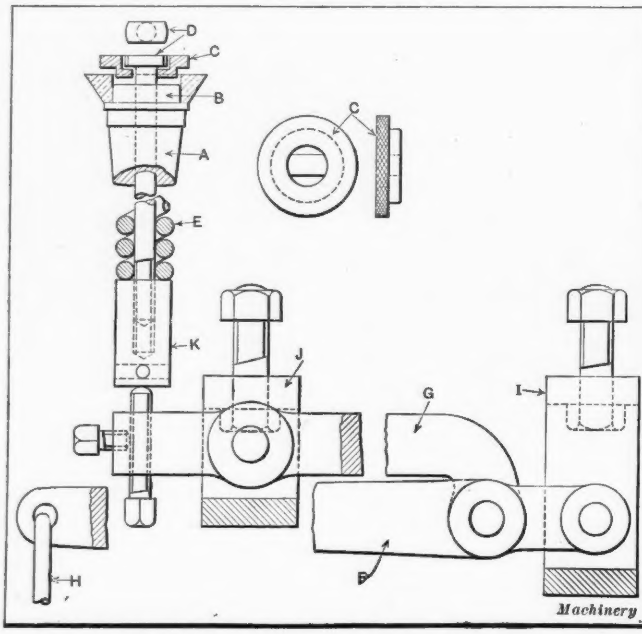


Fig. 10. Work-holding Mechanism used on Machine shown in Fig. 9

Operation 3: Finishing Groove.—From the roughing machines the rings go to the finishing machines, one of which is shown in Fig. 9. These are Leland-Gifford high-speed drilling machines equipped with special spindles to allow of taking heavy continuous cuts with the minimum of vibration. They are also furnished with special tables having a cross-feed similar to a milling machine; and on top of the table a circular milling attachment is mounted. The work is placed on top of the circular table, being positioned by a hardened stud which fits the center hole in the ring and also by a sliding pin which enters the escape hole. This pin has a vertical movement to allow for variation in the height of the escape hole, but no allowance is made for side play.

To hold the work down on the table, the mechanism shown in Fig. 10 is used. Spindle A revolves with the table, and has a nose B over which the work is placed and held by washer C fitted over the T-head bolt D; washer C is given a quarter turn, so that when the tension is released from spring E by removing the foot from a treadle which actuates the compound levers F and G through rod H, this tension will be brought to bear on the washer. Brackets I and J are fastened underneath the work-benches, and through them pass the levers and their fulcrum pins, while K is a long nut for adjusting the tension of spring E. After the work is in place the cutter is brought down to the proper depth by operating another foot-treadle, the depth being determined by means of a stop which is plainly shown at the top of the spindle head; the work is clamped in position by the knurled nut shown at the left of the spindle arm, which is split for the purpose. The stops which control the starting and stopping positions will be seen on the edge of the circular table, and they are adjustable by means of bolts which are held in a T-slot passing around the table. One of these stops is shown in Fig. 9, while at

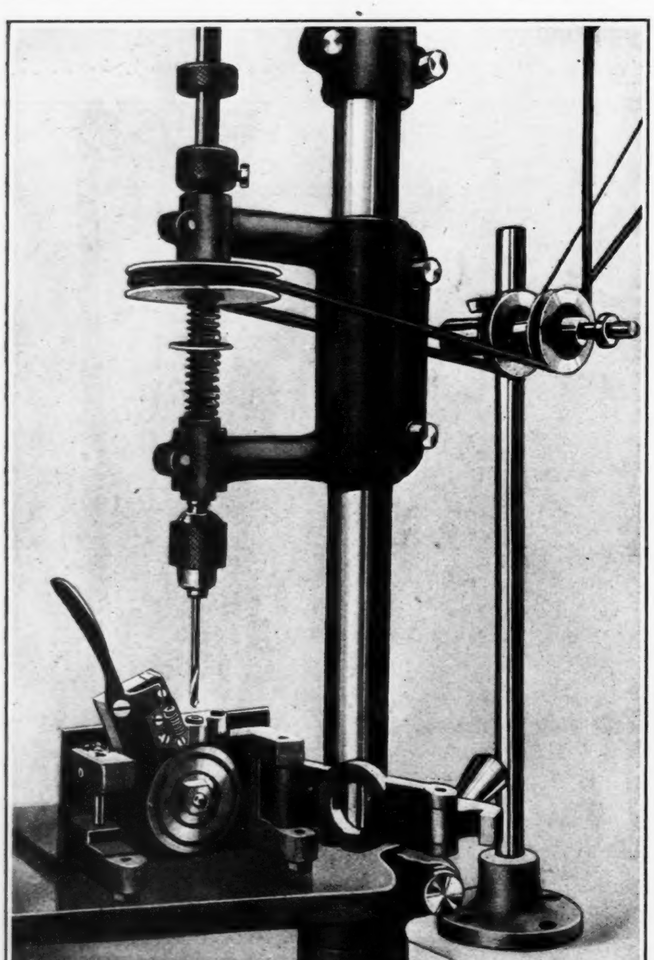


Fig. 11. Machine and Latch Jig used for drilling Setting Pin Hole

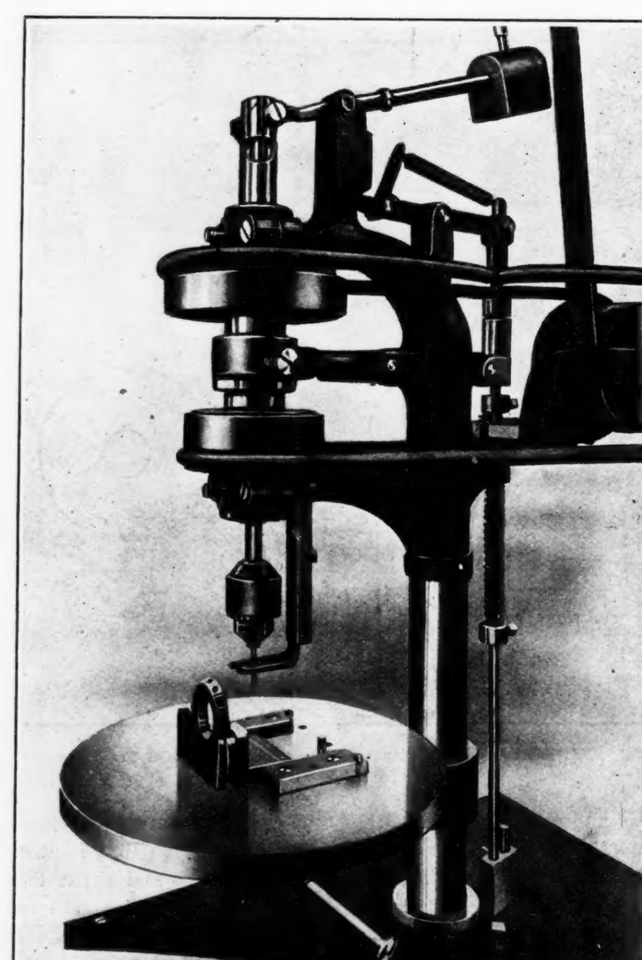


Fig. 12. Machine and V-block Fixture used for tapping Setting Pin Hole

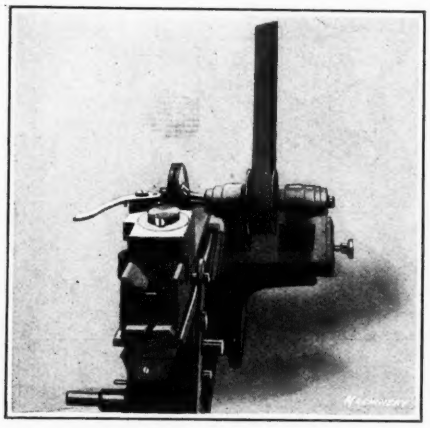


Fig. 13. Hand Milling Machine and Straddle Cutters for slabbing Sides of Setting Pin

the extreme left is shown the lever that operates the draw bolt which the stops strike against. At the front of the illustration, or on the right-hand side of the machine, is shown the hand-wheel used for revolving the circular table; and this wheel furnishes a ready means for applying power feed to the tables by simply cutting a groove in the rim and passing a round belt over it and back to a shaft which runs along the whole length of the bench on which the finishing machines are mounted. This gives a simple and effective feed mechanism, and the belts are arranged to slip when the table carrying the work has revolved and comes to a stop, continuing to slip while the operator is removing the finished ring and replacing it with a fresh blank.

Cleaning off the chips which collect on the work and table is accomplished by means of compressed air, the air hose and nozzle being shown lying across the clutch lever on the right-hand side of the machine, which starts and stops the cutter-spindle. The lubricant used is lard oil, some of the machines being furnished with a pump, while others are lubricated by the operator's dipping a brush in the oil and applying it to the rings and cutters. The capacity of each machine is between 1000 and 1300 finished rings in a ten-hour day. The cutters used for this work are of the end-mill type.

Operation 4: Rubbing off Burrs.—Rubbing off the burr thrown up by the finishing machine is done on a simple machine which carries an endless belt of fine emery cloth over a flat plate which backs it up and makes a perfectly flat surface on which to lay the rings. This operation takes but a second.

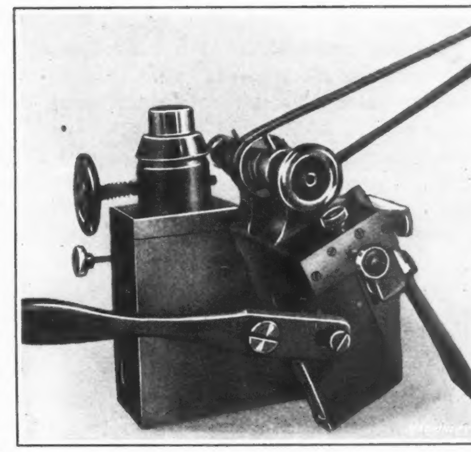


Fig. 14. Machine and Fixture used to mark Lighting Line on Fuse Rings

Operation 5: Drilling Setting Pin Hole.—Drilling the hole for setting pin *C*, Fig. 3, is done in a latch jig, the construction of which can be plainly seen from Fig. 11. The work is placed over a central stud, and located by a sliding pin which is worked by a finger-lever; then the leaf of the jig is closed and locked by means of the eccentric latch which is here shown open and swung over to the right. As first made, these jigs were not permanently attached to the drill press tables, but it was soon found that through the carelessness of the operators the jigs were often dropped on the floor and damaged. To prevent this, and also to increase the speed of operation, they were finally secured by means of angle-plates made of common steel angle iron planed on two sides to make them perfectly square. These angle irons were bolted to both the jig and the table. Set up in this way, the jigs were always square under the drills and the operators were free to use both hands for actual work rather than for handling the jig. At first, oil was used as a lubricant to prevent unnecessary wear on the drills and drill bushings, as the drill crowds hard against the bushing on account of the point striking against the angular edge of the ring. Later, however, it was found that for this and similar operations where the drill passes through a bushing, common

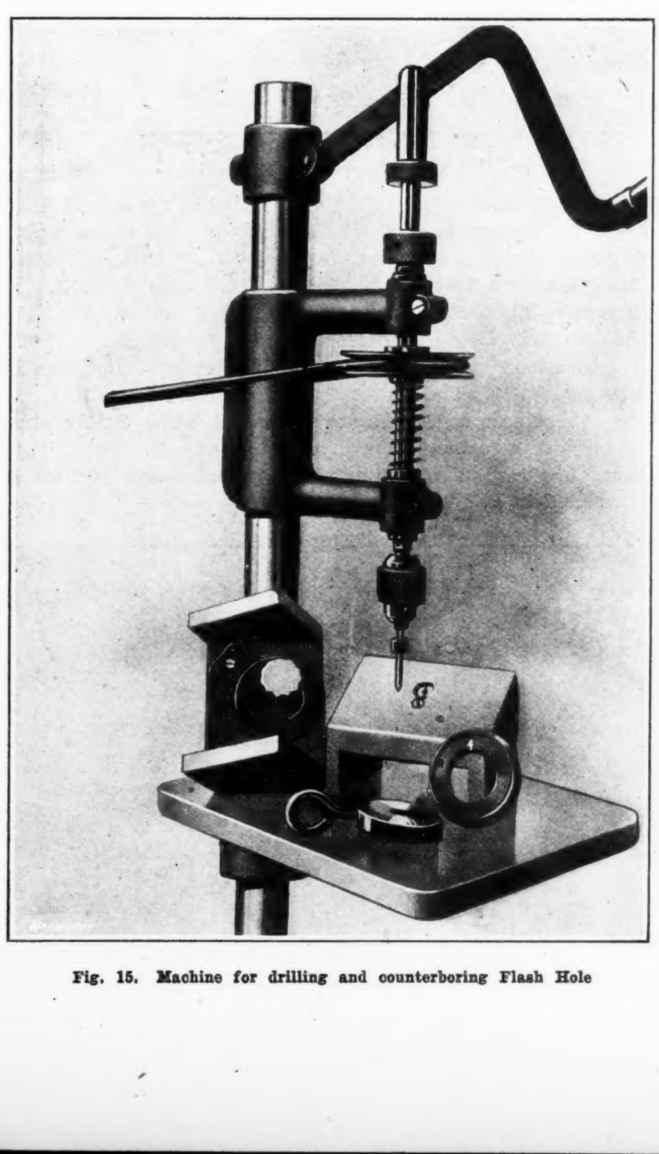


Fig. 15. Machine for drilling and counterboring Flash Hole

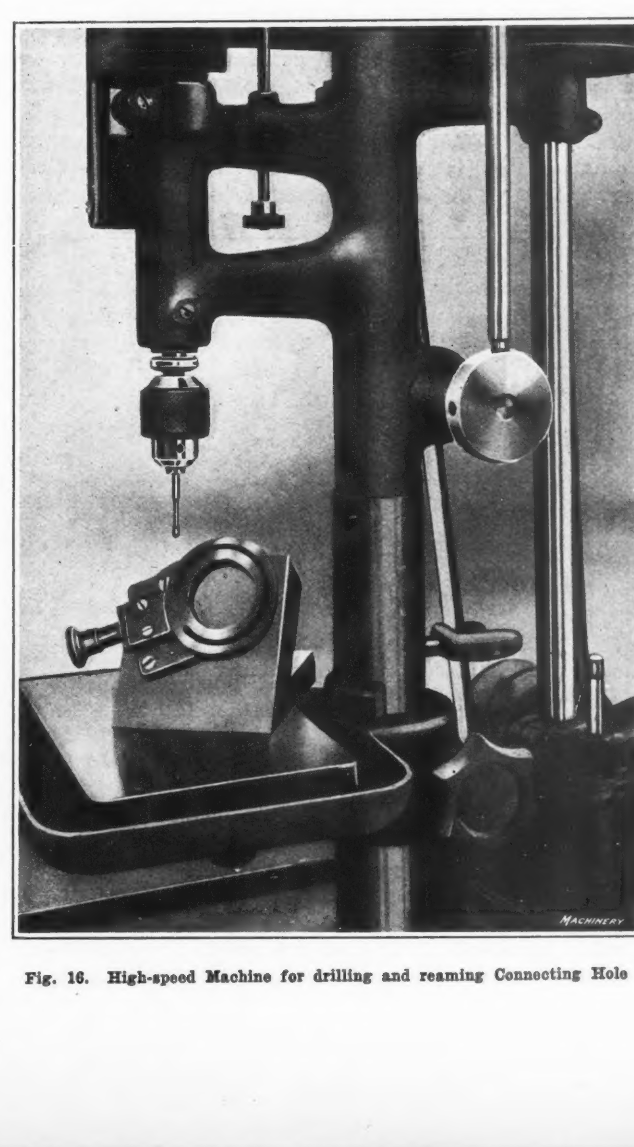


Fig. 16. High-speed Machine for drilling and reaming Connecting Hole

yellow soap gives much better results and leaves the work and the locating points clean, as the chips do not cling to them as they do when oil is used. This is a point well worth considering, as it takes time to clean away the chips from locating points.

Operations 6 and 7: Counterboring and Tapping Setting Pin Holes.—These two operations are performed by holding the rings in a simple fixture of the type shown in Fig. 12, which is to all intents and purposes a simple V-groove and angle-plate that carries the work and slides between two parallel pieces and back against a stop which positions the work under the counterbore or tap. The counterboring is done in a simple drill press, while the tapping is done on the tapping machine shown in Fig. 12.

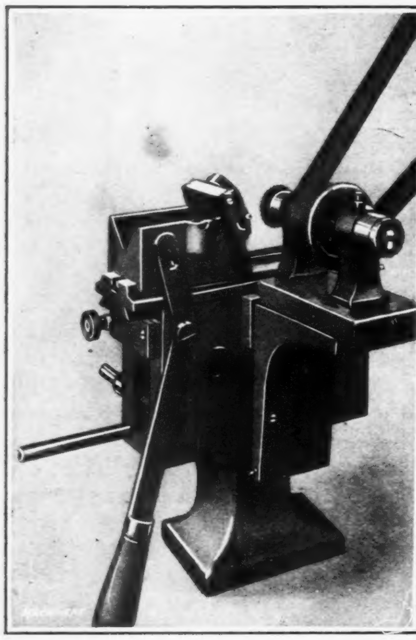


Fig. 17. Hand Milling Machine and Fixture used for cutting off Setting Pin to Length

Operation 8: Screwing in Setting Pin.—This is done by hand, starting the pin with the fingers, then catching the end in an ordinary bench vise and screwing it home.

Operation 9: Cutting Setting Pin to Length.—Fig. 17 shows this work being done on a simple type of hand milling machine. The work is mounted on a stud and the pin swung against a V-groove in a thin bracket secured to the side of the jig. It is held in place with the left hand while the right hand operates a lever at the side of the machine which feeds the work up to the saw. A guard over this saw prevents the operator from getting his hands cut, but it was removed to enable the saw to be seen in the illustration.

Operation 10: Slabbing Sides of Setting Pin.—Another hand milling operation is shown in Fig. 13, which consists of slabbing the sides of the setting pin with straddle milling cutters.

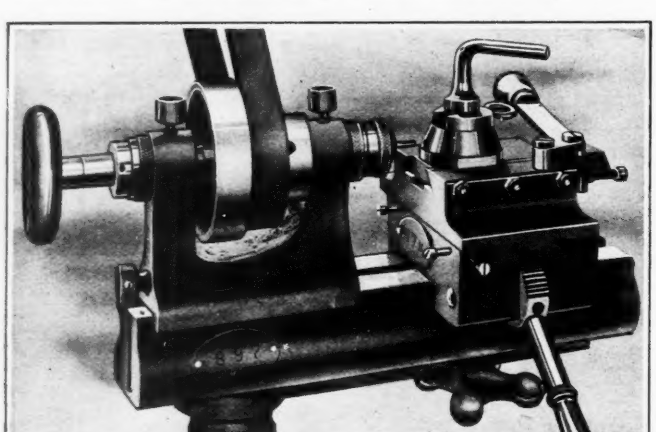


Fig. 18. Machine used for elongating and recessing Escape Hole

The work is placed over a stud shown on top of the slide and properly located by a sliding pin which is actuated by a spring and operated by the finger-lever shown at the left. The two cutters, mounted on the same arbor and spaced the proper distance apart, perform this operation very quickly.

Operation 11: Drilling and Counterboring Flash Holes.—Drilling and counterboring flash hole *D*, Fig. 3, is done on the angular jigs shown in Fig. 15, the so-called "counterboring" being done by using an ordinary twist drill which has been

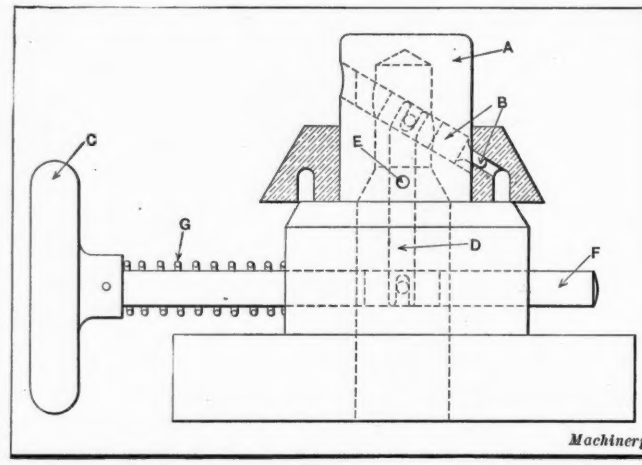


Fig. 19. Fixture used on Lighting Line Marking Machine shown in Fig. 14

ground straight across the cutting edge, with the exception of a little teat in the center that is left to cut a center by which the following drill will be located. The second drill, which is the one shown, is held in a long sleeve and is allowed to project only the short distance necessary for drilling the hole; the sleeve has saw cuts through the sides of it, and is provided with a collar and screw for binding the shank of the drill as it is adjusted after each sharpening. The sleeve also has a bearing in the bushing of the jig, and acts as an additional guide and support while the flash hole is being drilled. This work is done on two small drill presses which are placed

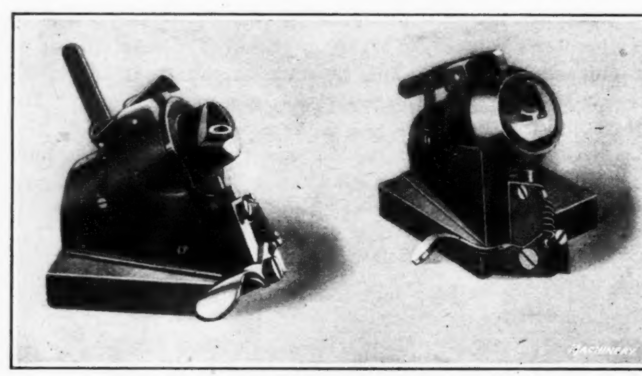


Fig. 20. Two Views of Jigs used for drilling Flash Hole in Top Ring

close to each other, with the tables adjusted to the same height so that the jig may be readily slid from one table to the other. This, of course, is a substitute for the regular multiple-spindle drilling machine usually employed for this class of work.

Operation 12: Drilling and Reaming Connecting Holes.—This is done on Langelier high-speed drill presses running at 10,000 revolutions per minute, the work being held on simple jigs as shown in Fig. 16. The drilling is done with a short, stiff twist drill which needs no bushing to support it, while the reaming is done with a reamer made in the form of a flat drill. This reamer is shown in the illustration. The connecting hole is shown at *E* in Fig. 3.

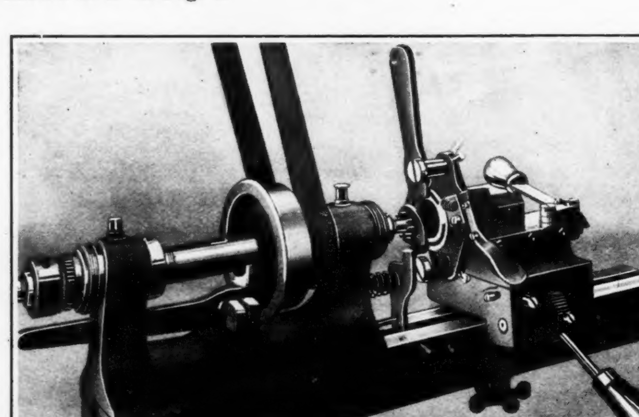


Fig. 21. Machine used for under-cutting Flash Hole

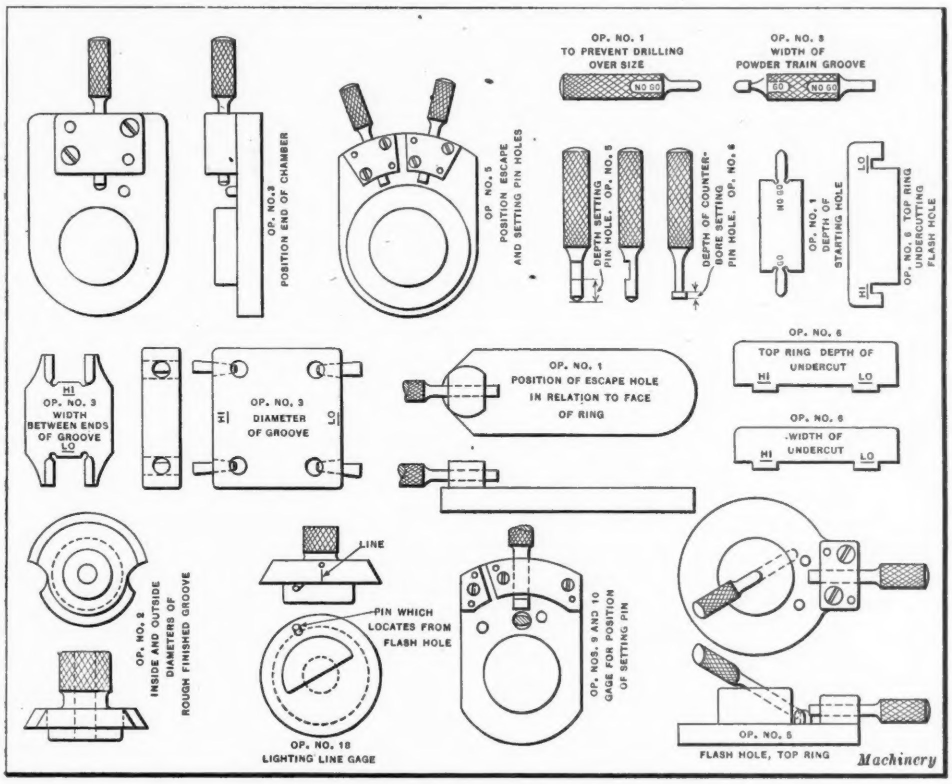


Fig. 22. Miscellaneous Examples of Gages used in testing Fuse Parts

Operations 13 and 14: Elongating and Recessing Escape Hole.—These operations are practically identical so far as the machines and fixtures are concerned, except that the recessing is done with a fixture that holds the work on an angle, one of the elongating machines being shown in Fig. 18. The operation is so simple that it needs little description. The cutters used for elongating the hole are simple four-fluted end-mills, the end teeth being cut to the center, while the recessing cutters are similar, except that they have six teeth and the center is cut away to allow of grinding to the ends of the teeth. Also, they are as short and stiff as they can be made, as their cut is not deep.

Operation 15: Burring Flash Hole.—This is done by hand with a simple three-cornered scraper.

Operation 16: Marking Lighting Line.—The machine for performing this operation is shown in Fig. 14. This is a type of hand milling machine which has a head mounted on slides that are adjustable in both a vertical and horizontal direction, and which can also be swung at an angle as shown. By the addition of the fixture shown in detail in Fig. 19, it became an excellent machine for this work. The machine is operated as follows: The ring is first placed over the locating nose *A* and properly positioned by sliding pin *B*, which has been held back by pressing on knob *C* that operates the pin through lever *D*. Lever *D* is pivoted at *E* and has slotted ends that engage pins passing through push-rod *F* and sliding pin *B*. Spring *G* is for holding push-rod *F* and also sliding pin *B* in place. When the ring is located in the proper position, it is steadied slightly by hand, and the saw is fed up to and across the work to cut the lighting line by operating the large lever shown in the foreground of the halftone Fig. 14, that illustrates the marking machine.

Additional Operations of Interest

The operations on the top ring, shown in Fig. 2, are practically identical with those already described, except the drilling of the flash hole *F* and under-cutting it as shown at *G*. The jigs for drilling the flash hole are shown in Fig. 20. The ring is placed over the central stud and properly located by a sliding pin which is operated by a thumb-lever; for additional security, the cam clamp shown at the top of the jigs is used. The drill bushing is located in the nose of the central stud, and the lubricant used is common yellow soap. Under-cutting the flash hole is done on the machine shown in Fig. 21; but this machine and its operation were fully described in the June number of MACHINERY, and so no further description will be given here. Figs. 22 and 23 show the gages used on the various operations.

* * *

The field for the application of electric arc welding is an extremely broad one. Practically every industry making use of iron and steel can utilize the electric arc welding process to distinct advantage. In foundries and machine shops many applications for arc welding can be found. Steel mills also use this method with great success. Rolls occasionally chip out. Instead of scrapping the roll or turning it down, one of the large steel companies has found that great economies can be effected by repairing the defective spot by means of the electric arc. The chipped portion is first filled in and welded, after which it is machined or chipped and filed to shape. After the work has been completed, it is practically impossible to detect the point at which the weld has been made except by close examination. The repairs are apparently permanent and will wear as long as any other part of the roll. This company is making all its repairs of this kind with the electric arc, and is also repairing worn wobblers and broken gear teeth in this way.

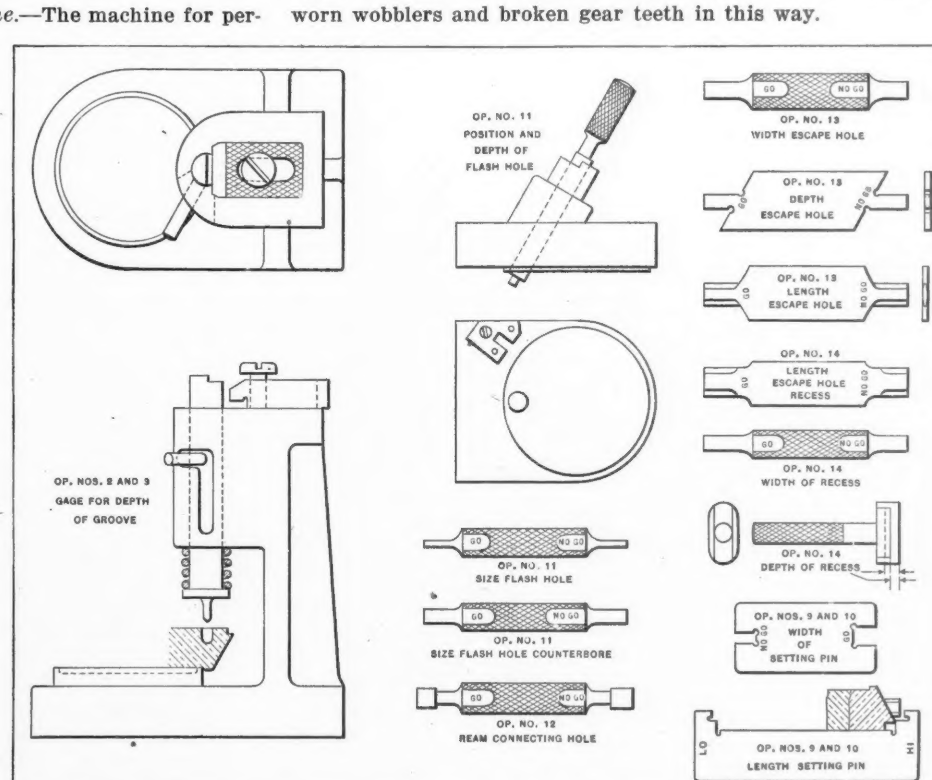


Fig. 23. Other Examples of Gages used in manufacturing Fuse Parts

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BUILDING MACHINE TOOLS FOR STOCK

The past experience of most machine tool builders goes to show that periods of exceptional activity are likely to be followed by times in which the demand for machine tools is relatively light, and that there are comparatively few periods in which the demand approximates a mean condition. But every successful manufacturer must regulate his investment in plant according to the mean demand if he is to secure a satisfactory return upon his investment. Periods of unusual prosperity present a great inducement to increase plant capacity to provide facilities for handling the full amount of business; but when the manufacturer follows this course, he often does so with the feeling that he is taking a speculator's risk as regards the returns on the increased investment that may be expected over a period of years.

Equally important with the maintenance of a balance between plant capacity and mean demand is the holding together of a manufacturing organization during periods of business depression. The most obvious way of conducting business to meet these two conditions is to first determine the manufacturing capacity necessary to produce the number of machine tools that can be sold under normal business conditions; then to develop a plant of this size and operate it at full capacity during slack times, placing unsold product in stock ready for sale at a time when the sales force is disposing of more machines than the factory is able to produce. Money put into stock accumulated in this way should yield a satisfactory return on the investment, because in slack times the cost of materials will usually be considerably below normal and the same is true of wages. Money to provide for the accumulation of stock can be borrowed at a low rate of interest during times of industrial depression. Consequently, machines produced at such times and sold during periods of unusual business activity, will yield a margin of profit considerably above the average. The experience of machine tool builders who have adopted this practice has fully demonstrated the wisdom of following such a course.

* * *

HIGH-SPEED STEEL TESTS

Comparative tests of high-speed steels may be misleading if the results are taken to indicate the real efficiency of the brands tested. Suppose that two steels, A and B, are tested at a cutting speed of, say, 100 feet per minute, and A breaks down after cutting a length of only one foot, while B stands up for ten feet. While there is no doubt that B is shown to be superior to A, the result is not a fair determination of the relative value of the two steels. It might be that if the cutting speed were reduced to, say, ninety feet per minute, A would stand up as long as B. In fact, it sometimes happens that the relative durability at reduced speed is reversed.

In judging of the relative merits of tool steels, it is apparent that a number of factors should be considered besides the actual extreme cutting speeds at which they break down. Is the difference in durability offset by disadvantages as to other characteristics? How do the costs compare? Can the superior steel be obtained of uniform grade, or do bars in the same lot vary greatly? Can it be readily forged? These and other questions may be adversely answered; and if so, the disadvantages may outweigh the slight advantage of mere cutting speed. Of course, if other things are equal, the user is warranted in paying a considerably higher price for an increase of cutting speed as low even as 10 per cent.

* * *

COOPERATIVE SERVICE

A machinist and engineer recently wrote the editor requesting some information on machine shop floors as suggestions for use later when he expected to erect a new shop. The inquiry was answered as part of the busy day's work; an unexpected letter of appreciation for the service rendered was received, from which we quote: "This is certainly a grand service you render those connected with the machine line, and we very much appreciate being able to call on you when needed to solve any such stiff problems where we can profit by others' experience."

The writer hit the nail on the head when he referred to the fact that by writing to the editor he could profit by others' experience. That is just what a mechanical journal like MACHINERY should offer in the way of service—the means by which mechanics the world over may interchange ideas and ask questions regarding problems on which others have had experience. It is by working cooperatively instead of competitively that the plane of mechanical engineering is raised. Common prosperity comes from common knowledge, and every mechanic should be liberal enough to add his little quota of experience whenever it is needed by others.

* * *

VICIOUS CIRCLE OF RISING PRICES

The European conflict has upset economic relations throughout the world, and the waste and non-productiveness of the warring nations are reflected in rising prices for clothing, food and practically every necessity of life. The high cost of living has affected seriously the welfare of workers everywhere. Strikes and demands for higher wages are general. But higher wages mean higher cost of materials and manufactured goods, which, in turn, makes the need of still higher wages imperative. Just how far the index will swing around the vicious circle of rising prices is a serious question. It is evident that it cannot go on indefinitely without causing disaster. Business men should consider to what extent they are contributing to a grave situation when they join in the movement to jack up prices. They should take heed and strive to apply the brakes wherever possible instead of adding momentum to the movement. There is no doubt that the war has been made a pretext for raising prices and adding to profits when the necessity for raising prices did not exist.

The example of one great motor car manufacturer who in the midst of a carnival of price raising has lowered the price of his improved motor car and who pays his employes the highest wages shines as "a good deed in a naughty world." It is evident that what the average manufacturer needs more than anything else is to be shown that improving the efficiency of manufacturing reflects greater credit and gives more profit in the end than mere price raising. Price raising on pretext in prosperous times because trade is brisk is a twin evil of price cutting in dull times to sell goods. Both practices cause instability and are ruinous to prosperity.

HEALTH INSURANCE[1]

POINTS IN WHICH IT DIFFERS FROM WORKMEN'S COMPENSATION—RESULTS OF HEALTH INSURANCE IN OTHER LANDS

BY FRANK F. DRESSER[2]

HEALTH insurance is not a new matter. Bismarck proposed the first compulsory health insurance law in Germany, in 1883, as a sop to the Socialists. Austria and Hungary followed in 1888 and 1891, Luxemburg in 1901, Norway in 1909, Servia in 1910, Great Britain in 1911, Russia and Roumania in 1912, and the Netherlands in 1913. Systems other than general compulsory insurance are found in Belgium, Italy, France, Spain, Sweden, Denmark, and Switzerland.

The need for such insurance in the United States appears from the following data, which, though the sources of information are meager and the data were gathered before the recent rise in wages and costs of living, seem to be agreed upon by the proponents of the measure and are sufficient for the present purpose. Of the wage earners in the principal industries who are heads of families, one-fourth earn less than $400 a year, one-half less than $600, and four-fifths less than $800. Less than one-tenth earn $1000 a year. Of the women, eighteen years old and over, in the principal industries, one-fourth earn less than $200 a year, and two-thirds less than $400. More than one-half the families of wage earners are dependent on other sources of income than the earnings of the family head. These sources are most frequently earnings of wife and children and the payments from boarders and lodgers.

Investigation seems also to show that the workingman's family of average size, that is, father and mother and three dependent children, has required an income of $800 to maintain adequate subsistence. Of this, $650 goes for rent, food, clothing, heat, and light, leaving for all other purposes, including medical care, insurance, and the like, about $150. As the employe in this country apparently loses nine days a year through illness, and as there are some 30,000,000 of wage earners, the wage loss alone at two dollars a day is over one-half a billion dollars; medical care and drugs cost about a quarter of a billion more. The attempts of the workers to distribute their loss by means of industrial insurance, membership in trades union relief funds, fraternal societies, or establishment funds are insufficient. Being purely voluntary, they reach only the thrifty and the less needy.

Proposed Health Insurance Bill

The proposed bill of the Association for Labor Legislation compels all employes earning $100 or less a month, except casual workers not employed for the purpose of the employer's trade or business and some other slight exceptions, to be insured. It excludes the self-employed and the families of workers. When the insured servant is disabled by sickness or accident he receives two-thirds of his wages from the fourth day of disability during disability, but for not more than twenty-six weeks in any twelve months. If he is in a hospital, this cash benefit is discontinued, and instead one-third of his wages is paid to his dependents. Benefits are to be paid for any sickness, accident or death not covered by the Workmen's Compensation Act, and if the insured is entitled to benefits from other sources he shall receive in all no more than 90 per cent of his wages. All necessary medical and surgical attendance and treatment are furnished from the first day of sickness during disability, but not exceeding the twenty-six weeks' period. This includes obstetrical aid to insured women during confinement. All necessary medical supplies, appliances, etc., are to be furnished, but not exceeding a cost of $50 in any year. A funeral benefit of $50 is to be paid when an insured member dies.

The cost of this insurance, including administration expenses and contributions to reserve and guaranty funds, is borne two-fifths by employes, two-fifths by employers, and one-fifth by the state. The employer is compelled to pay to the insurance carrier, on the day he pays his employes, the contribution due from him and from them, but is permitted to deduct the employe's contribution from the wages paid him. Employers in one line of industry may be required to pay sums different from employers in another line, according to the degree of sickness hazard in that industry, and an employer whose establishment shows an excessive rate of sickness may be required to pay an increased rate.

The insurance carrier may be, first, private societies approved by the insurance commission, either labor unions, benevolent or fraternal societies or establishment funds. In such cases the state's contribution is paid to the approved society and the employer's contribution for such of his employes as are insured in any such societies is paid into the state guaranty fund. Second, the carrier may be local health associations or trade health associations. A state is divided into districts, each containing not less than 5000 insured persons. In each district is established one or more local health associations and one or more trade health associations. It is also possible, in a district, for employers or employes in the same line to establish a local trade health association. The government of each association consists of a committee, which elects a board of directors from other than its own members, one-half of each body being employers and one-half employes. An employer is a member of all associations to which any of his employes belong, and he has as many votes in any association as he has insured workmen there, but no employer may have more than 40 per cent of the total vote.

The immediate control of all ratings, of medical service, and of administration is left with the several associations, subject, however, to supervision. The general control is lodged in a state social insurance commission of three members, appointed by the governor. A council of twelve, one-half being employers and one-half employes, is elected by the directors of the several associations. It is their duty to pass on the annual report of the commission and to see and discuss any general regulation of the commission before it is finally adopted. Ten per cent of the state's contribution is paid into a guaranty fund to be used for the relief of any carrier.

An insurance carrier, if it chooses, may also grant additional benefits, such as medical care and supplies to members of the insured's family, funeral benefits for members of the family, cash maternity benefits to insured women, and may extend the period of benefit, but not to exceed fifty-two weeks.

Arguments of Bill's Proponents and Cost of Plan

Like all other legislation based upon the collectivist theory, this bill looks to the advantage of a class and not of an individual and rests upon the principle that the more fortunate or efficient or thrifty among the insured, as well as the community at large, shall share the burdens of the weaker members of society. Its proponents argue that this plan, because it touches the pocketbook of everyone so sharply, will spur on preventive measures and will purchase and distribute medical care. They justify compulsion by the experience here and abroad which shows that voluntary insurance, even if subsidized, does not reach the needy. They justify the contribution of the state and of the employers by saying that the workers cannot bear the necessary cost themselves and must be helped; that it is to the advantage of the state to diminish its expenditure for poor relief and to have a well and self-sustaining citizenry; that it is to the employer's advantage to have more efficient and constant workers; and that to some degree both the state and the employer are responsible for illness among the insured class.

The cost of the plan is problematical. The data in this country are vague, and such foreign data as are available are difficult to transpose into our terms. The German costs have been rising steadily since 1884, the days of sickness per insured have increased rather than diminished, and the duration of illnesses has lengthened remarkably. A similar condi-

[1] Abstract of a paper presented before the National Machine Tool Builders' Association's convention, New York City, October 24, 1916.

[2] Address: American Steel & Wire Co., Worcester, Mass.

tion is observed in other countries having an insurance system. The actuaries' estimates for the British Act have been in several instances considerably exceeded. The state contribution is about twice what it was supposed would be necessary, while less relief is being given than the statute appears to require.

It has been computed, arguing from German and British experience, but realizing the almost total lack of necessary data, that the cost of the sickness, medical, and funeral benefits, including administration costs, but excluding, apparently, any contribution to reserves and the quite considerable sums which employers must in the first instance pay for their accounting department, would be between the limits of 3 and 5 per cent, say about 4 per cent, of wages. Applying this to a single state, say Massachusetts, and assuming the average wage to be $570 a year and that there are about a million persons who would be insured, the cost to that state would be about $23,000,000 annually. Of this amount, the workmen would contribute nearly $9,000,000, the employers $9,000,000, and the state about $5,000,000—an increase in the present state tax of over 40 per cent. The state's contribution, as well as its payment as employer of state and municipal employes, is raised by the general levy upon all taxpayers. The employer's contribution, plus his increased state and municipal tax, will become an item in his cost of production, to be charged, so far as possible in the competitive rivalry of the several states, in the price of his product and paid by the consumer, or else be saved by greater economy, as, for example, reducing wages. A great portion of the consumers are the insured workmen and their families, who thus, besides their direct contribution, will indirectly bear in the increased cost of necessaries or in lesser wages a large proportion of the contribution of the employers and the state. In this, therefore, as in so many similar proposals, it would seem that the class which it is hoped to benefit is made to pay the price.

Objections to Plan

Health insurance is desirable purely as a means of distributing illness loss. If such loss should be distributed, insurance is in some form necessary, and the inability or the disinclination of the lower paid, both here and abroad, to carry insurance voluntarily shows that resort must be had to compulsion. The method of enforcing compulsion adopted in the German, British, and most other systems, as well as in the proposed bill, through requiring employers to collect the contribution due from their employes necessarily limits the benefits of this insurance to servants, and the large class of equally needy self-employed, which in England is assumed to be somewhat greater than the employed class, must be left to voluntary insurance.

In addition, so long as the public thinks the employer and the state are paying any part of the cost, it will be willing to have them pay more. The legislature, influenced by political considerations, will year by year extend the scope of the statute, increase its benefits, alter the proportions of contributions and the like, just as in the compensation legislation, where in the five sessions since the Massachusetts Act was passed it has been altered in sixty-four particulars. The employer seeking to diminish his sickness cost may refuse to employ men likely to be sick. The defective man of any age, or the man who, reaching forty-five, has entered upon the period of increasing illness hazard, will be excluded from regular employment, and, at a time of his greater need, will see his opportunities of earning reduced. Instead of making it easier to employ such men, this plan will enlarge the class of dependents. This has been the result in England. Nor does it follow that the employer will seek to reduce this cost by study and further expenditure for health; he may more easily reduce his costs in other lines.

Health Insurance and Workmen's Compensation Theories

The scheme of health insurance applies, however, to the losses beyond the logical scope of the compensation theory. It includes non-industrial accidents and diseases, invalidity due to either, deaths due to either, and maternity benefits. The health insurance theory is thus capable logically of covering all the enumerated classes of non-industrial losses among all members of the community, but in the proposed bill, besides the limits indicated, invalidity insurance and cash benefits during confinement are excluded. To losses such as these the occupation itself has either no causative or a very slight and doubtful causative relation. Other factors, such as heredity, personal habits, ignorance, lack of public health provision, epidemics, bad home environment, and the like, are the sole or principal causes. The distinction between the compensation and the health insurance theories is clearly shown by considering the effect of hazard and premium. When business is rushing, more men are employed and more are injured; the payroll is larger and the profits are greater. Whether the rate is or is not increased, the premium paid to take care of the increased loss is larger. But when business is stagnant, men are out of work, their wages diminished or ended, and the payroll and profits are smaller, yet the hazard of illness, because of this unemployment, rises. That means both an increase in the rate and in the payments to meet the larger need, but the payments to meet the larger need must come from employers who are making no profits and from employes who are getting no wages.

While in workmen's compensation the hazard and the premium rise and fall together, the rate remaining fairly constant, in health insurance, as the hazard and the rate rise, the premium, or rather the possibility of paying the premium, falls. This difficulty can be avoided only by treating health insurance from a strict actuarial standpoint, undertaken unsuccessfully in England and entirely disregarded in the proposed bill.

The time for choice has come. Will the manufacturers permit these crude and uncertain legislative regulations to continue, agree that industry is responsible for certain preventable inducements to disease, and inflict upon themselves and the community the rule of thumb penalty of health insurance, or will they study the conditions and set about to cure the evils, whether they be evils in the mills or in the general health conditions of the towns? That matter is difficult and costly for the great majority of mills, but it is comparatively simple and inexpensive for a great industry. A committee can determine the limit of effective production of a latheman, clerk, or fireman, can discover the mill conditions of dirt, ventilation, and the like, as some boards of health are now undertaking to do, and can suggest remedies; even a six months' watch of sick workmen will produce a mass of data to prove what is now guesswork.

The possession of such knowledge may prevent much evil legislation, and the application of this knowledge may not only reduce accident and sickness loss, but increase profitable production. In Germany, the average sickness has risen during its insurance experience from six to nine days per year. In the model Leipzig Fund, the average for the years 1888 to 1905 was nine days per year; in 1912, it was 10.4, and in 1913, 11.3. In France, on the other hand, where compulsory insurance does not exist, the workmen lose fewer days of sickness than they did ten years ago.

It is said by a German investigator, Dr. Bernhard, that the knowledge of insurance has sometimes, consciously or unconsciously, caused illness and frequently delays recovery. While before the statute twenty to forty days were sufficient to heal a fractured collar-bone, for example, the doctors have had to revise that estimate, since it now takes about eight months; so a break of the upper arm, for which thirty to forty days used to be sufficient, now lasts four months. Stomach and intestinal disorders became strikingly frequent in the building trades, and no reason for them peculiar to that trade being discovered except that it was seasonal, it was thought that these troubles, difficult to detect, were used as a species of unemployment insurance. As a result of his investigation, he states: "The opinion is gaining ground that we are in reality arriving at the opposite of what was intended. For workingmen's insurance legislation is showing undesirable moral and hygienic results which were originally regarded as a necessary evil, but which are gradually making the blessings of workingmen's insurance appear very questionable. The material to prove the correctness of this proposition is grow-

ing constantly. The most prominent physicians are warning against the threatened consequences; and no one has the right to designate these physicians as 'anti-social' who have had the courage to give utterance to opinions displeasing to the toiling masses."

A similar opinion is voiced by Dr. Naegeli in his inaugural address at the University of Tübingen, while Dr. Friedensburg, former president of the senate in the Imperial Insurance Office (retired), after twenty-odd years' service, ends his article on the "Practical Results of Workingmen's Insurance in Germany" with the words: "I deem it a deed well done to have called attention once again to the all-pervading cancer that is destroying the vitals of our state."

If the matter is considered from the poverty aspect, we realize that the poverty of Europe is not that of the United States. The National Civic Federation Committee quotes Harold Begbie as saying, "There is nothing here, absolutely nothing, to compare with the most shocking and ubiquitous poverty of Europe!" And also an English social worker who, criticizing the statute, said, nevertheless: "Something had to be done. The act gave some relief somewhere, but its principles spring from the gospel of despair."

* * *

COILING SHELBY SEAMLESS TUBING

Shelby seamless steel tubing has some important advantages over butt- or lap-welded pipe for making coils and bends, as well as for the service required of the finished pipe after it has been bent. The uniform quality of the material, even gage of the walls, and freedom from burns, scabs and laminations makes it possible to coil and bend very light gage tubing on very short radii. This, with the wide range of sizes and thicknesses, allows large areas of coil surfaces for heating and condensing in a small space, and the light gages which can be used decrease the heat loss. For extremely high pressures, the freedom from defects, the absence of welds, and the high bursting point make possible a large factor of safety, without excessively increasing the thickness of the tubing.

Fig. 1. Bent Tube for cooling Open-hearth Furnace Door

The Roessing-Ernst Co., Pittsburg, Pa., has been making coils and bends of seamless steel tubing for some time, and has done considerable experimenting in coiling and bending round and special shapes. This firm has special machinery of its own design for making coils and bends in any shape or size without filling, heating, or the use of mandrels. The section of the tubing is not deformed, and the circle and pitch of coils can be made exact. For coils requiring more than one length of tubing, the tubes are placed end to end and electrically welded together, without leaving a ridge or any unevenness either inside or outside. As many lengths as are required for a coil may be joined in this way, and are supported on carriers and rollers. One end of the tube is then started through a machine which consists of a series of rolls that are driven by an electric motor. These rolls are grooved to fit the outside of the tube, and are knurled to draw the tube into the machine and force it through the bending rolls. As the tube comes from the bending rolls, an arm comes into contact with the back of the tube and records on a large dial the radius of the bent portion. By keeping the finger on the dial constant a perfect circle will be made, and by gradually changing the position of this finger a spiral will result. A series of cross rolls are provided which can be raised or lowered to give any pitch required.

Fig. 1 shows a bend made from seamless tubing 2½ inches outside diameter by ¼ inch thick, this part being used in connection with a system for cooling the door of an open-hearth steel furnace. Fig. 2 shows a mold for forming the inner tubes of automobile tires. This is made from tubing 3 inches outside diameter by 1/16 inch in thickness; and the seamless tubing is bent into a perfect circle of 36 inches outside diameter. Fig. 3 illustrates an interesting example in which a number of lengths of seamless tubing have been welded together in order to form a piece of sufficient length for the complete coil. Careful reference to this illustration will show that there are two coils, one inside the other. The outer coil is 3 feet, 6 inches outside diameter, and is made of tubing 3 inches outside diameter by 3/16 inch in thickness. The inner coil is 2 feet, 8 inches outside diameter, and is made of tubing 2½ inches outside diameter by 3/16 inch in thickness. The total length of the finished coil is 21 feet; the outer coil contains 410 feet of 3-inch tubing, and the inner coil contains 300 feet of 2½-inch tubing. These two coils are connected at the ends, and the finished coil is used for condensing light oil in an oil refinery.

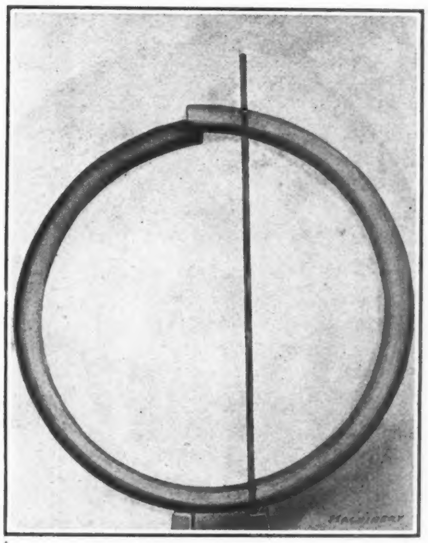


Fig. 2. Mold for Inner Tubes of Automobile Tires

E. K. H.

* * *

The manager of a well-known machine building plant in Sweden writes that it is extremely difficult to obtain materials and tools. It is practically impossible to buy high-speed steel drills at any price, and ordinary carbon steel drills are quoted at three times the usual prices. He intimates that the smaller neutral countries are looking to America to take a definite step toward proposing peace, and it seems that the opinion in Sweden is that the United States is neglecting a duty toward the world by making no protest against the continuation of the war. Living expenses are from 50 to 55 per cent higher than usual, and the conditions generally, except in the case of a few manufacturers and dealers, are very bad.

* * *

Dr. Wertheimer, dean of the faculty of engineering of the University of Bristol, England, has proposed the following system of training: A student will attend the university until he has passed the intermediate examination for the B.S. degree in engineering. If his record is good and he is a promising student, he will be recommended to a firm which will allow him to enter its plant for fourteen months. He will then return to the university for two years; after that, if he has given satisfaction, he will return to the plant.

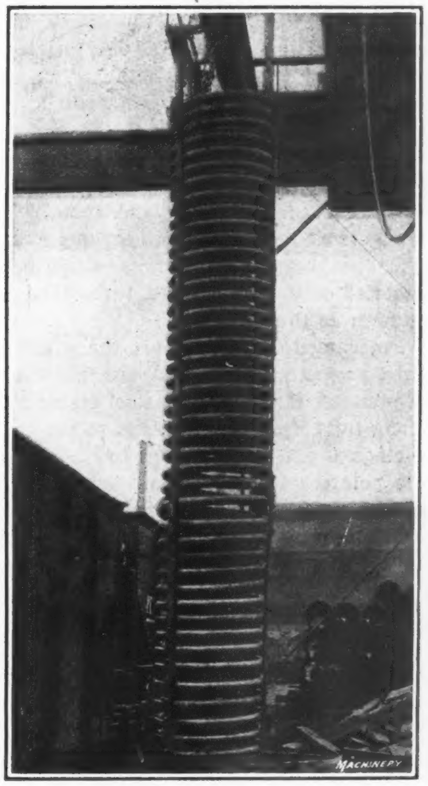


Fig. 3. Double Coil used for condensing Light Oils

Profile and Indicating Gages-2

by Douglas T. Hamilton[1]

GAGES of the indicating type are gradually superseding solid gages on many classes of work because of their greater sensitiveness. For instance, they are used for testing external and internal cylindrical work, parallelism of shafts, relation of angular surfaces, height and depth of shoulders and holes, concentricity of parts, cam shapes, strength of springs, etc. The previous installment of this article dealt with the type of indicating gages used for cylindrical external and internal work; in the following, attention will be given to the other uses mentioned, as well as to the gages used for testing balls and ball bearings, and the use of box-type inspection fixtures for work having a number of holes that must bear a certain relation to each other.

Testing Parallelism of Shafts

For testing the parallelism of shafts, the indicating gage is very satisfactory. One means of determining if a shaft lies in a parallel plane with the base of a machine is illustrated in Fig. 34. In this case it is desired to determine whether or not the needle bar lies in a parallel plane with the base of a sewing machine. The gage consists of a steel base *A* resting on four feet *C*, which, as shown, come in contact with the top surface of the table. These feet are hardened, ground and lapped in the same plane. The hardened tool steel plungers *B* which come in contact with the needle bar are flat on one end and spherical on the other. These plungers fit loosely in the bearings *E* and are held from dropping out by adjusting nuts *F*. The bearings are so constructed as to give a slight turn when the plungers are raised as high as they will go.

Fulcrumed on studs *G* are the pointers *D*, which have hardened projecting arms that are in contact with the upper end of plungers *B*. The sheet steel frame *H* is bent at right angles along the bottom and screwed to the base. Right and left coil springs *L* act in opposition to the plungers so that they turn the pointers to the extreme outer position, when the gage is not in use. When the pointers are to be adjusted, the instrument is set on parallels, and a height gage inserted under each plunger successively, the plungers *B* being adjusted so as to bring the pointers to zero. On this particular gage a limit of $\pm$ 0.005 inch is provided.

Testing Relation of Surfaces at Right Angles

Many different indicating devices have been constructed for testing the relative positions of angular surfaces, and in Fig. 35 is shown a simple gage for determining if the base of a gas engine cylinder casting is square or at right angles with the bore. This gage consists of a base *A*, frame *B*, pivot *C*, and indicating lever *D*. The body of the gage is made in two parts to facilitate machining. The indicating lever support is fastened to the body with screws and dowel-pins, and extends into the cylinder so that the center of the lever pivot is somewhat below the face of the flange of the casting. By placing the gage on the cylinder flange and bringing the knife-edges *a* and *b* on the lever into contact with the cylinder wall, any variation is shown by the mark at the upper end of the gage. This can be so laid out that plus or minus limits can be provided. The reason for placing the pivot below the cylinder flange is to have it receive the thrust when the indicator is moved against the side of the cylinder bore. A spring above the pivot holds knife-edges *a* and *b* in contact with the cylinder wall. The gage is simple in construction and operation.

Indicating Height and Depth Gages

For determining the relative heights of two shoulders, a height or depth gage is necessary. Gages of the multiplying lever or dial indicating type are best adapted for this purpose. Fig. 36 shows a height gage constructed on the multiplying lever principle. This consists of a base *D*, having two shafts *E* fastened to it and connected at the top by a link. On these shafts is a sliding member *G*, which can be locked securely in any position by screw *H*, acting upon two clamping bolts, thus obviating springing of the gage when in use. The adjusting nut *C* operates part *I*, which is carefully fitted in the slot. On the same part is a shoulder *J* to which the arm *A* is fastened. This arm is made from tubing and is similar in shape to opening *K*. It is made a tight fit on the holder at *J*, and a pin put through to fasten it securely. The oblong tube *A* is now cut along the line *Z–Z*, and inside of it are placed the levers which are arranged to give readings to one-half thousandth inch. While this gage has many admirable features from the point of view of accuracy, it is of little value except for tool-room use. In the first place, it is too complicated, and in the second place, it is too easy for the machine operator to "fake" the gage. It is evident that a gage designed for any particular piece should be so made that universal adjustment is not possible. In other words, its range should be limited to the particular work for which it is designed.

Indicating Gage for Testing Over-all Length and Thickness of Base of Shrapnel Shells

An indicating gage which fulfills two functions—gaging the over-all length, as well as the thickness of the base of shrapnel shells—is shown in Fig. 37. This gage comprises a base *A* in which three pins are driven to center the shell, an upright *B* for supporting the indicating mechanism, and attached to the top of upright *B* an indicating lever support *C*, which

[1] Associate Editor of MACHINERY.

is so mounted that it is free to swing in an arc. The device for indicating the thickness of the base of the shell consists of a rod *D* that has a hardened and ground tool steel point *E* and a limit pin *F*. A boss formed on bracket *C* is provided with a step, the height of which is 0.020 inch, or the manufacturing limit allowed on the thickness of the base. The limit pin *F*, when brought around, coincides with either one of these points, according to the thickness of the shell. The desired thickness, of course, is indicated when the lowest surface of limit pin *F* is located equidistantly between the high and low points on the limit step. To insert the shell in the gage, it is necessary that rod *D* be removed from bracket *C*.

The indicating device for the over-all length consists of a multiplying lever *G*, pivoted to bracket *C* at the point *H*, and attached by a pin to plunger *I*. Plunger *I* is hardened and ground on its lower surface and contacts with the end of the shell. The reading is obtained from the segment *J*, which indicates the limits on the work. It will be noticed that this fixture is free from springs and is of simple construction.

Indicating Thickness Gages

The simplest form of indicating thickness gage is the micrometer caliper, but as this type of gage is well known, it

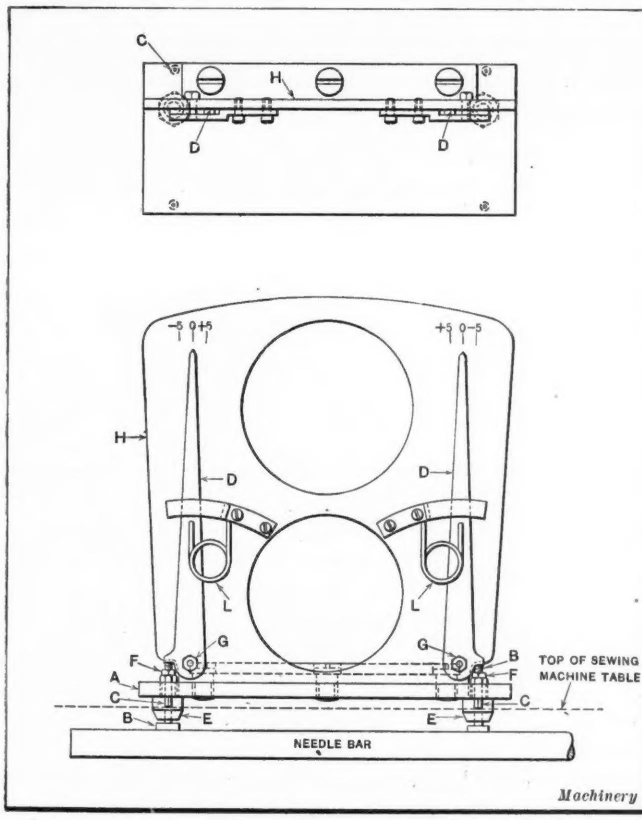


Fig. 34. Indicating Gage for testing Parallelism of Shaft

will not be described here. Another simple form of indicating thickness gage is shown in Fig. 38. This was designed especially for gaging the thickness of the wall of cartridge cases near the head end. It consists principally of two caliper jaws *A* and *B*, which are made long enough to reach down into the case, a handle *C* for holding the gage, indicating pointer *D* and graduated arc *E*. A combination locating stop and support *F* is also provided to keep the jaws in alignment with each other, and locate their measuring points at the desired distance from the open end of the case. In use, the jaws of this gage are slipped over the walls of the case, and readings taken at various points around the circumference. It is tested from time to time by the setting block *G*.

Another indicating thickness gage which is used for the same purpose as that illustrated in Fig. 38 is shown in Fig. 39. As this illustration shows, this gage is of the stand type, and supports the cartridge case being inspected, by means of a horseshoe support *A* held on upright *B*. Two other posts *C* and *D* carry the gaging points, one of which, *E*, is held rigidly in post *C*, whereas point *F* is free to slide and is kept out by

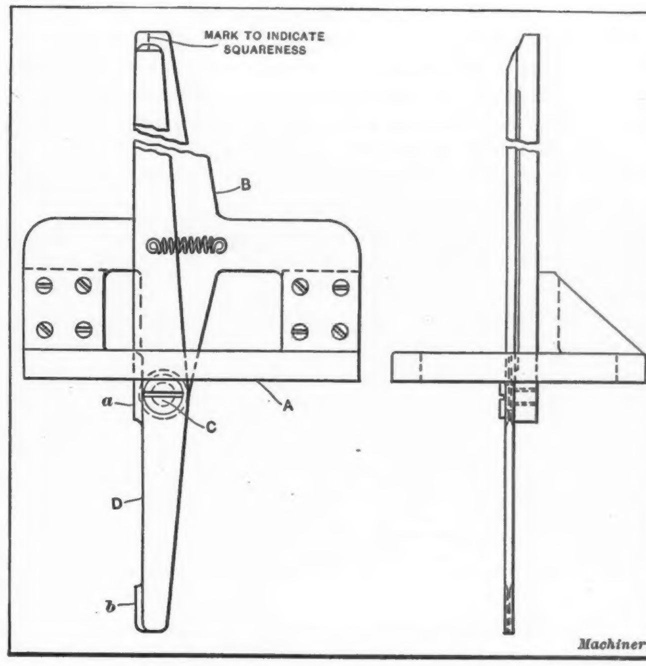


Fig. 35. Indicating Gage for testing Squareness of Base of Cylinder Casting with Bore of Cylinder

means of spring *G*. The upper end of post *D* is notched to form a limit step, and plunger *F* is provided with a line which must line up between the two steps when the wall is of the correct thickness. A height gage *H* is also provided which enables the thickness of the head to be checked at the same time that the wall is being inspected.

Indicating Thickness Gage for Shrapnel Shells

An indicating gage for testing the thickness of the walls of shrapnel at a point slightly above the powder pocket where the inner wall is straight is shown in Fig. 40. This consists of a sheet-steel frame *A* carrying a bushing *B* which fits in the nose of the shell, a roll support *C* for keeping the gage in line with the axis of the shell, and two measuring points *D* and *E*. Measuring point *D* consists of a hardened, ground and lapped block, which is riveted to the frame *A*, whereas point *E* is a roll attached to a multiplying lever *F*. Lever *F* swings over a marked segment *G* which indicates the limits on the work, and a flat spring *H* keeps roll *E* in contact with the work. In using this gage, the member *I* is inserted in the shell and located by bushing *B*. The gage is gripped by the handle and moved around the circumference of the shell to test its thickness at various points. Block *J* is used to test the gage for wear.

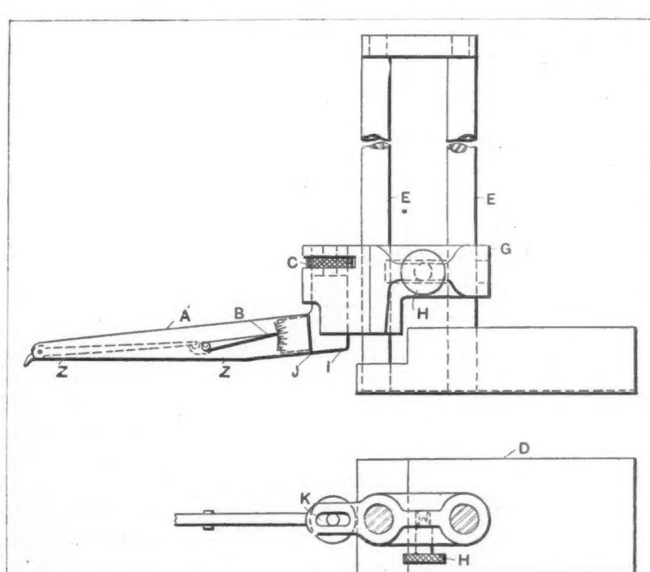


Fig. 36. Indicating Height Gage which is Objectionable because of its Wide Range of Application and Possibility of being tampered with

Concentricity Gages

There are several methods of determining whether or not a hole and an exterior surface are concentric with each other. The simplest way is to use a gage of the type shown in Fig. 41. This is not an indicating gage, but is shown here simply to illustrate the least expensive type of gage for concentricity gaging. It is built along the lines of the standard plug gage, with the exception that it is provided with a limit bar which controls the amount of eccentricity of the hole and the exterior surface. It will be noticed that bar *A* is provided with a step giving the "Go" and "Not Go" limits. It is also formed to a knife-edge to reduce the amount of bearing surface to the minimum. The plug *B*, of course, goes in the hole in the work and the knife-edge on bar *A* is located at a distance from the axis of the plug equal to the radius on the work.

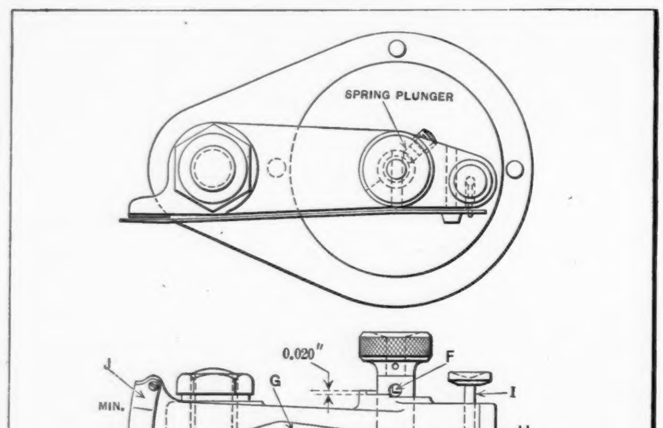


Fig. 37. Indicating Height Gage used for inspecting Thickness of Base and Over-all Length of Shrapnel Shell

Another simple gage that is used to test the relation of one hole to another, the two holes being eccentric to each other, is shown in Fig. 42. This gage is of simple construction and is also built along the lines of the plug gage, having two ends, one giving the "Go" and the other the "Not Go" size. The gage consists of a body *A*, in which two plugs *B* and *C* are fastened by pins, as shown. Two disks are also fastened to the faces of plugs *B* and *C*, one disk *D* being made so that it enters one of the holes in the work, which is a combination time fuse powder train ring. The other disk *E* is made to fit in the hole which is eccentric to the one in which plug *D* fits. Plugs *D* and *F* are of the same size, whereas plugs *E*

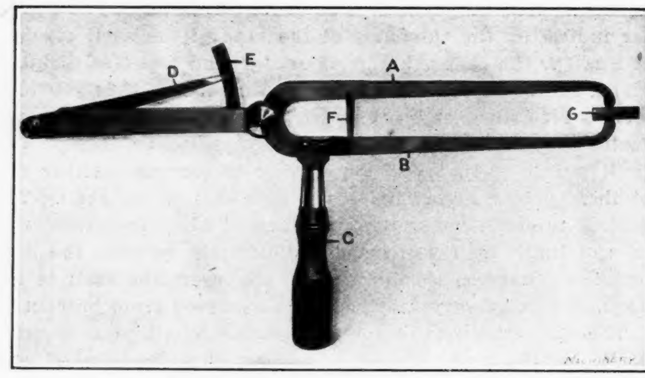


Fig. 38. Caliper Type of Thickness Gage for testing Thickness of Walls of Cartridge Cases

and *G* are of different sizes, the difference in diameter being such as to control the manufacturing limits on the work. The center location of the two disks in relation to each other is the same on both ends of the gage, the difference in diameter being the factor that controls the limit on the work. In using this gage, the work is tried on first the "Go" and then the "Not Go" end. If plug *E* goes in and plug *G* does not, the work is satisfactory.

Testing the Squareness and Concentricity of Piston-pin Holes with Body of Piston

Two interesting gages, one for testing the squareness of the piston-pin hole with relation to the exterior surface of the

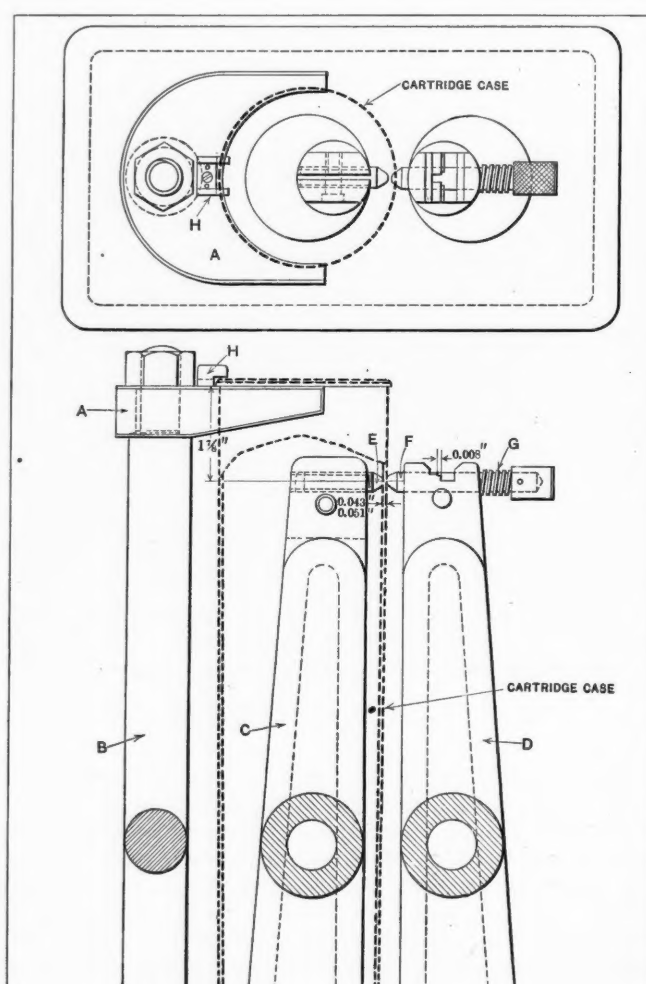


Fig. 39. Stand Type of Indicating Thickness Gage for testing Walls of Cartridge Cases

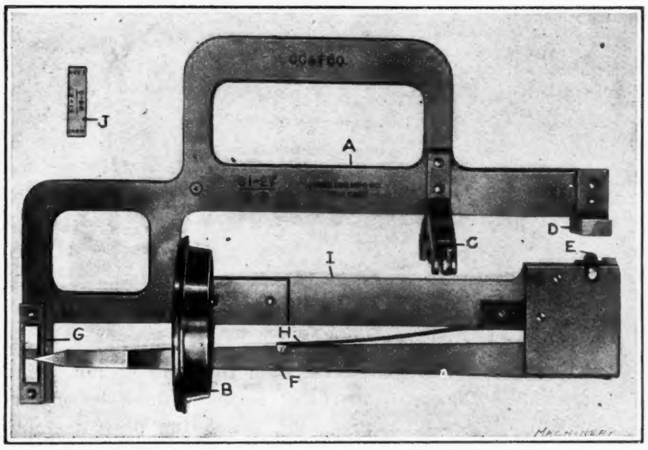


Fig. 40. Indicating Thickness Gage for testing Thickness of Walls of Shrapnel Shells

piston, and the other for testing the concentricity of the piston-pin hole with relation to the exterior surface of the piston, are shown in Fig. 43. The gage shown at *A* is for testing the squareness of the piston-pin hole with relation to the body of the piston, and consists of a plug *a*, which is made a good fit in the piston-pin hole, and carries a bracket *b* held in place by a screw *c*. Bracket *b* carries a micrometer spindle *d* which is used for testing the squareness of the hole.

In applying this gage, the plug is pushed into the piston-pin hole until the shoulder *e* contacts with the surface of the piston. The micrometer spindle is then brought to bear first at one end—near the head—and then near the base of the

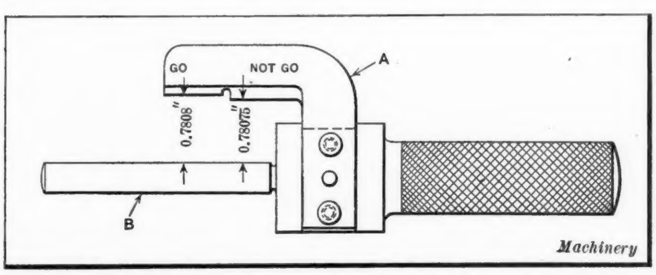


Fig. 41. Simple Type of Concentricity Gage based on Limit Principle

piston, and the amount of variation between the two points is read off on the thimble of the micrometer. The plug is made to enter freely enough into the piston-pin hole, so that the gage can be turned around to bring the micrometer spindle into the desired position.

The gage shown at *B* is of somewhat similar construction to that shown at *A*, except that a dial indicator is used in place of the micrometer screw. The dial indicator *f* is held in a bracket *g*, as illustrated, and is adjusted in this bracket so that its indicating point or plunger comes directly in line

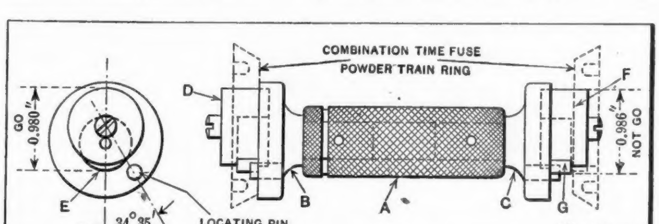


Fig. 42. Another Concentricity Gage of the Plug Type

with the vertical axis of the piston when shoulder *h* of the plug is in contact with the surface of the piston. After one side of the piston has been tested, the gage is turned around and the other side tested to see if the piston-pin hole is exactly central with the exterior surface of the piston. The gage is provided with two feet, as shown, for supporting it.

Method of Testing Concentricity of Gear Blanks

One method of testing work to see whether it is concentric or not before machining is shown in Fig. 44. This illustration shows a dial indicator testing gear blanks which are to be cut on a gear-hobbing machine. After the series of blanks is fastened on the work-holder and the work-holder supports are put in place, the dial indicator is brought in contact with the work and held by clamps as shown. The work-spindle is then rotated, and the movement of the dial indicator shows whether the exterior surface runs true or not. If not, it is an indication that the work has not been accurately machined or that the work-arbor has been thrown out of correct align-

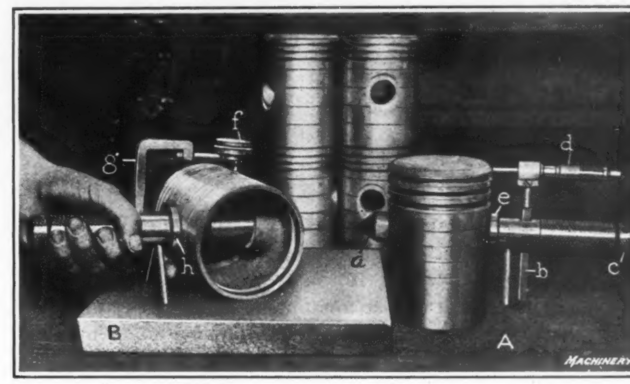


Fig. 43. Indicating Gages for testing Squareness and Concentricity of Piston-pin Hole in Relation to External Diameter of Piston

ment. By taking this precaution, the chance of cutting poor gears is reduced.

Testing Concentricity and Radial Position of Cutter Teeth

A testing device used by the Union Twist Drill Co. for determining whether the teeth of milling cutters are equidistant from the center or not, so that they will do their correct share of the work, is shown in Fig. 46. This fixture also determines, by means of a separate indicating needle, whether the teeth

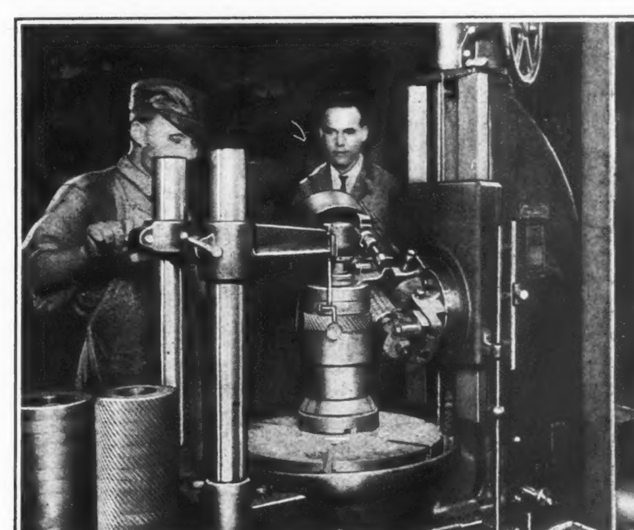


Fig. 44. Testing Concentricity of Gears on Gear-hobbing Machine

are radial or not. It consists of a base carrying an adjustable stud on which the cutter to be tested is held, bushings being supplied for fitting different sized holes in the cutters. The cutter is then brought up to the micrometer spindle and rotated to determine if all of the teeth are of the same height. The work is then shifted over to the indicating pointer, and this is brought in contact with the face of the teeth. If the teeth are radial with the center, the indicating mark on the

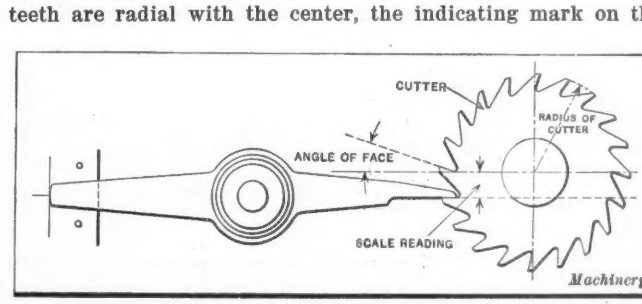


Fig. 45. Diagram illustrating how Indicating Lever for Under-cut Teeth is set off Center on Fixture shown in Fig. 47

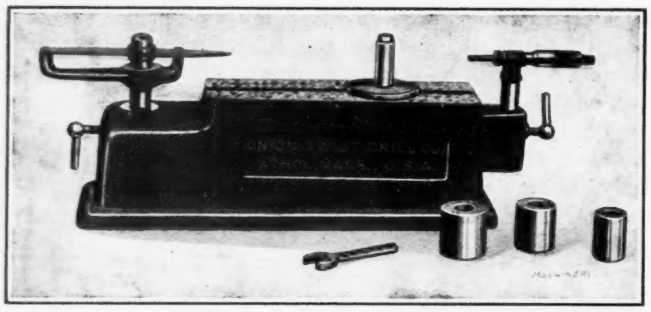


Fig. 46. Fixture for testing Concentricity of Periphery and Bore of Milling Cutters and Position of Face of Cutter Teeth of the Radial Type

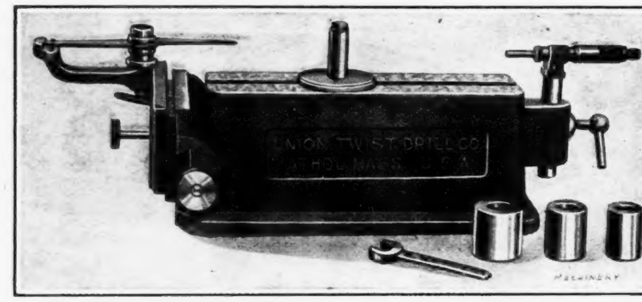


Fig. 47. Similar Device to that shown in Fig. 46, for testing Under-cut on Teeth of Milling Cutters and Hobs

opposite end of the pointer registers zero on the arm of the fixture.

A fixture which can be applied to milling cutters or hobs having under-cut teeth is shown in Fig. 47. This gage indicates if the cutter is true, if the teeth are equidistant from the center, and if the proper amount of under-cut is provided. The faces of the teeth are tested by means of a finger mounted on a slide. Readings can be taken from the scale shown at the left-hand end of the gage, which is graduated in fiftieths of an inch. The proper readings can be obtained by multiplying the radius of the cutter by the following constant for different angles of face, or under-cut:

Angle of Face or Under-cut, Degrees	Constant, Inches
5	0.087
10	0.174
15	0.259
20	0.342
25	0.423

Fig. 45 shows how this reading is obtained. For testing if the faces of the teeth are radial, the slide on the fixture in Fig. 47 is brought to zero, and consequently does not have any lateral movement. When the teeth are under-cut, however, the fixture is moved over the amount given by multiplying the constant by the radius of the cutter, and the pointer should then indicate zero if the cutter is correct. The opposite end of the fixture carries a micrometer test instrument for determining whether the points of the teeth are equidistant from the center or not; in other words, if the hole and points of the teeth are concentric with each other.

Concentricity Gage for High-explosive Shells

Fig. 48 shows a simple type of indicating concentricity gage for inspecting high-explosive shells. This consists of a base A carrying an arbor B on which there are two bushings, both slightly tapered. One bushing fits the hole near the bottom and the other at the open end or nose. The shell is simply held on the fixture by hand and rotated to determine whether the exterior surface is concentric with the bore or not. The concentricity of these two surfaces is determined by means of a multiplying lever arrangement, consisting of a movable plunger C, link D and pointer E. Pointer E is fulcrumed at the point G, giving a multiplying movement of 12 to 1. In other words, a variation of 0.001 inch in the work moves the extreme end of the pointer 0.012 inch.

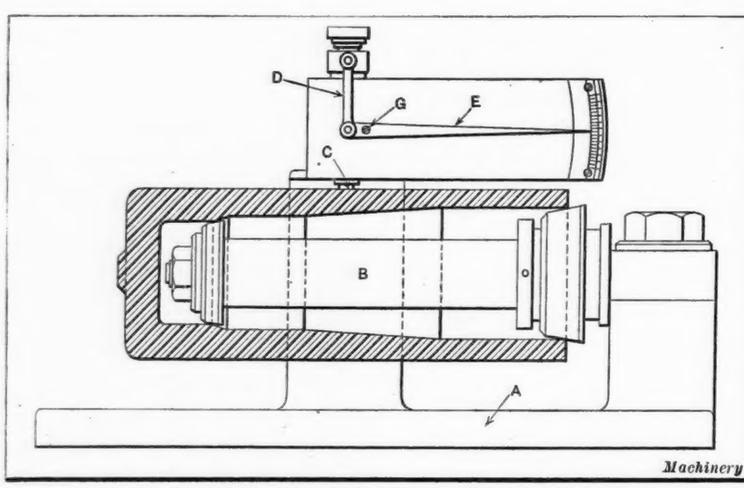


Fig. 48. Simple Type of Indicating Concentricity Gage for High-explosive Shells

Gage for Testing Concentricity of Shrapnel Shells

An indicating type of concentricity gage for testing shrapnel shells is shown in Fig. 49. This differs from that shown in Fig. 48 in that the shell is supported from the exterior instead of from the interior surface. It comprises a base A provided with several bosses for holding the indicating lever mechanisms, as well as the rolls B and C for supporting and positioning the shell. Rolls B are so positioned that the axis of the shell is inclined to the base of the fixture at an angle of 5 degrees, 25 minutes. This is done to keep the base of the shell constantly in contact with the roll C, and thus locate it properly in relation to the contact point of the indicating levers. The two points on the shell which are tested for concentricity are the bore of the powder pocket and the exterior surface of the shell close to the base.

The indicating mechanism which determines the concentricity of the powder pocket consists of a rod D to which a handle E is attached, provided with a flattened end fitting in the corresponding slot in the boss on the fixture. The indicating lever G is fulcrumed at the point H and swings over the arc I provided with three points, mean, low and high. The indicating device for the exterior of the shell is held on a post J and consists of an arm K held between two adjusting nuts L. The indicating lever M is fulcrumed at the point N and swings over the scale O, having marks, mean,

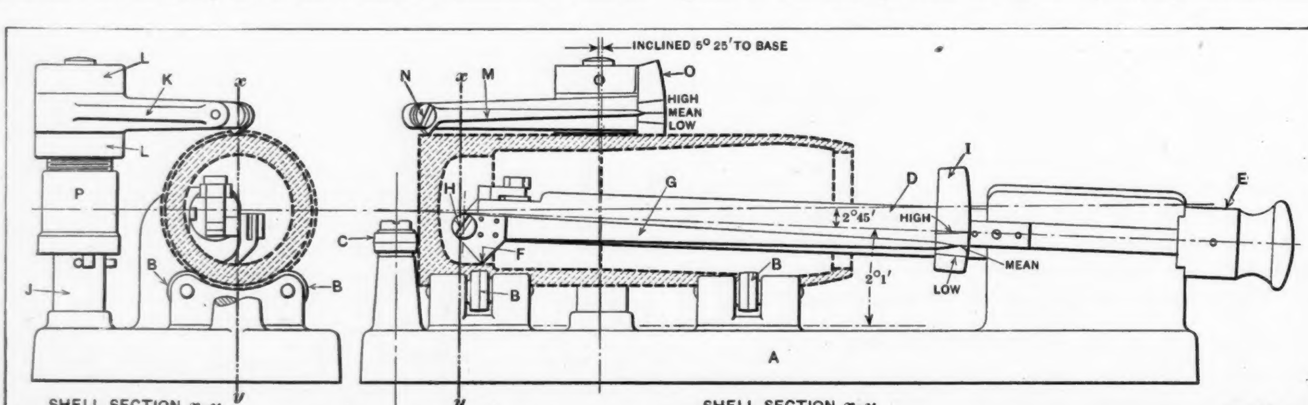


Fig. 49. Gage for determining Concentricity of Powder Pocket and Exterior Surface near Base End of Shrapnel Shells

low and high. In order to locate the point of the fulcrum lever *M* directly in line with the vertical axis of the shell at its highest point, the bushing *P* is provided, carrying a pin which comes in contact with stop-pins in the rod *J*.

Inspecting Cams on Gas Engine Cam-shaft

A class of gaging which requires accurate and careful inspection methods is the testing of cams on gas engine camshafts. These cams must be tested for shape, lift and angularity of position. The requirements are that the profile of the cam between the opening and closing points must fit a contour gage having limits of ± 0.003 inch. When the concentric part of the cam is within the limit of tolerance, which is 0.001 inch, the body plus the lift must be correct to within 0.003 inch. The arc of the opening and closing points on the cam must be correct to within $\pm 1\frac{1}{2}$ degree. The relative positions of the opening and closing points on all cams must be correct to within ± 1 degree, and this error must not be cumulative. The usual clearance provided between the top of the valve lifter and the lower surface of the valve stem is from 0.003 to 0.010 inch.

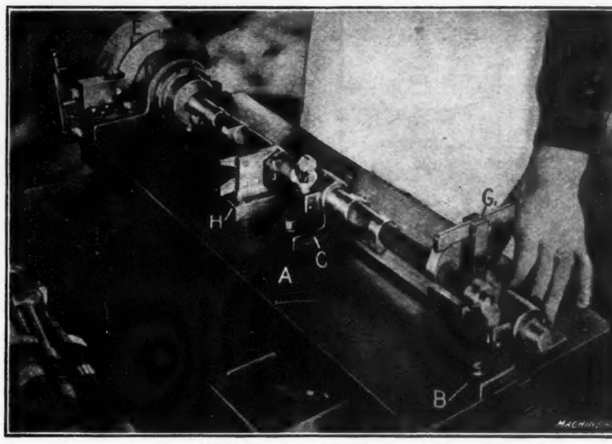


Fig. 50. Simple Type of Gas Engine Cam-Testing Fixture for determining Shape of Cam, Angularity, Lift, etc.

A simple method of accomplishing this work, which, while not employing the indicating type of gage, is of sufficient interest to warrant description here, is shown in Fig. 50. This fixture is used for testing the position of the cams on an integral four-cylinder engine cam-shaft. The fixture comprises a bedplate *A* on which three brackets *B*, *C* and *D* are held. Brackets *B* and *C* are used as supports only, and are provided with hinged caps held by thumb-screws to facilitate the insertion and removal of the cam-shaft. The bracket *D* carries a special chuck for gripping the work and is furnished with an index plate *E* which has eight notches to correspond with the number and position of the cams on the shaft. This disk is located in the various positions by a tapered plunger that is held in contact with the disk by a spring and is removed by the handle *F* to index the disk. The highest point of the cam is tested by the T-gage *G*, which has "Go" and "Not Go" ends on the bar G_1. The angularity and shape of the cams are tested by the V-gage *H*, which is provided with knife-edge points and is used in connection with the indexing disk. This gage also has "Go" and "Not Go" V-grooves, which are made to the exact shape desired. The brackets on this gaging fixture are all located from a central groove in the bed which keeps them in correct alignment.

Another method which employs the use of a dial test indicator is shown in Fig. 52. This device is of comparatively simple construction and consists of a base *A* sufficiently heavy to stand firmly, and a vertical support *B* held in the base by means of screws. The upper end of the support is drilled and reamed to receive the shank of the dial indicator *I*, and is split and provided with a screw to clamp it. The indicator point *P* is a spherical segment whose radius *r* is one-half the diameter of the cam roll. The center line of the indicator must be in the same position in relation to the cam-shaft that the roll is in the gasoline engine, which in this case is on the center line of the camshaft. The distance *d* is then one-half *D* and the height *H* is such as to give a good contact between point *P* and cam *C* and allow the full limit of the indicator movement.

In use, the cam-shaft is provided with a dog and mounted between the index centers of a suitable fixture. The first step then is to find the center of the keyway for the cam-shaft gear, as the cams are generally laid out with reference to a keyway. Assuming that the cam is of the shape shown in the illustration, and the center coincides with the center line of the keyway, also that the opening and closing points are in the position occupied by the cam rolls *R* represented by the dotted circles to the right of the illustration, the actual opening and closing points are then one-half 102 degrees, or 51 degrees in advance and 51 degrees back of the starting point. Now, with the indicator set on the dwell of the cam allowing for a rise of 0.003 inch—"the clearance under the valve stem" below zero—and with the indicator in the position shown, the

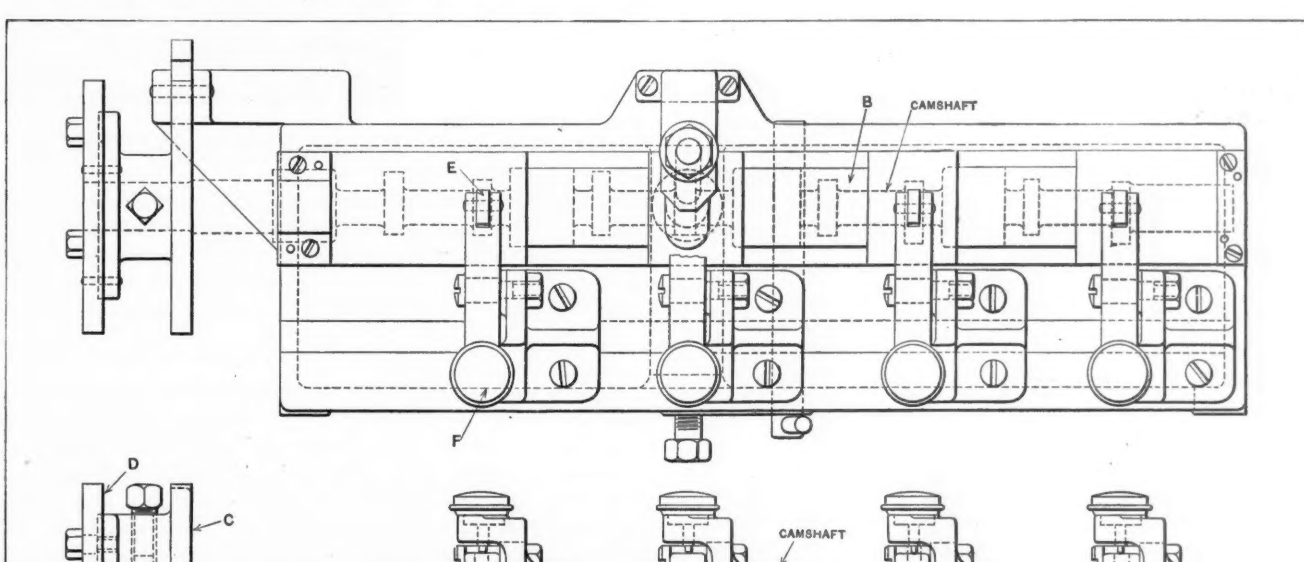


Fig. 51. Multiple Type of Cam-shaft Testing Fixture used for inspecting Cam-shafts for Twin Four-cylinder Engines

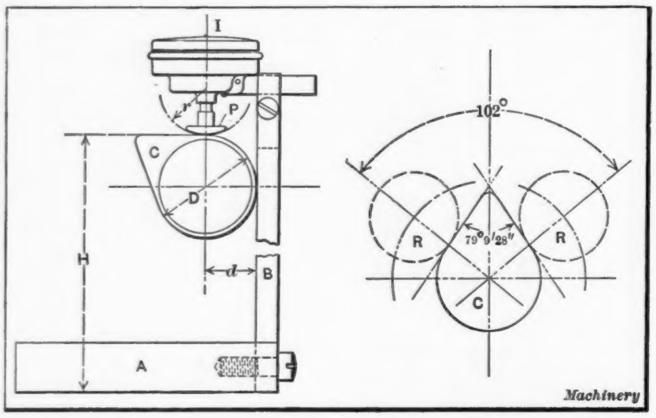


Fig. 52. Method of using Dial Test Indicator for inspecting Gas Engine Cams

cam-shaft is indexed to the correct angle. If the work has been accurately done, the indicator needle should just begin to rise at the 51-degree angle. If not, it will rise either too soon or too late, and the amount of error is read off on the index circle of the indicator. The relation of all the other cams to the keyway is tested in a similar manner, taking all the opening points in their firing order and then all the closing points. The amount of error sometimes found in spite of very careful work is surprising, and this method of testing approaches a high degree of accuracy.

Multiple Indicating Cam-shaft Gage

The multiple indicating cam-shaft gage for testing the exhaust and inlet cams for twin four- or eight-cylinder engines is shown in Fig. 51. This consists of a fixture for holding the cam-shaft and indexing it while being tested and brackets for carrying four dial indicators, so that four cams can be tested at the same setting of the cam-shaft. For the other four sets of cams, the cam-shaft is shifted and the testing operation repeated. The fixture consists principally of a base *A* to which four V-blocks *B* are attached. The bearings on the cam-shaft rest in these V-blocks. After the cam-shaft is held in the V-block and located in the correct position, a double index plate *C* and *D* is fastened to the end of the shaft in order to give the correct angular position of the cam-shaft when testing the location of the opening and closing points on the cams. Four cams, as previously mentioned, are tested at a time. The index plate is moved into the position desired and the reading is transmitted from the cams by the rolls *E* to the needle of the indicators *F*.

The reading on the dial indicator is taken when the cam has raised the roll 0.005 inch, thus allowing for the clearance between the end of the push-rod and the valve stem. As soon as readings have been taken from four cams and they are found correct, the lever *G* is operated, which releases the single clamp that holds the cam-shaft in position in the fixture,

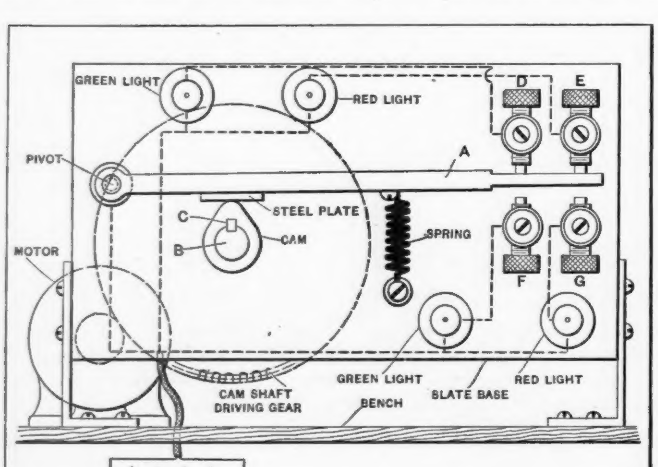


Fig. 53. Electrical Device for inspecting Gas Engine Cams of Detachable Type

bearing down with sufficient pressure to prevent it shifting, but at the same time allowing it to be rotated by means of the index plate. The cam-shaft is then shifted along the fixture to bring the remaining four cams into position under the indicators, and a similar procedure followed. It will be noted that the fixture is constructed so that the index-plate moves with the cam-shaft when it is shifted over to bring the second set of cams into the testing position. By means of this gage the testing of cam-shafts is greatly simplified in that four readings can be taken at one setting.

Electrical Cam-shaft Gage

An electric device for testing individual cams is shown in Fig. 53. This gage consists principally of a pivoted arm *A* that is raised or lowered by the thrust of the cam being tested and is held in contact with the cam by a helical spring. The cam is carried on the shaft *B*, which is provided with a key *C*, the cam being slowly rotated by means of a small motor located behind the slate base to which the entire mechanism is attached. Connection is made with an electric battery in such a manner that when the cam raises and lowers the arm *A*, it closes the electric circuit by making contact with the adjusting screws *D*, *E*, *F* and *G*, respectively. If the throw of the cam is too slight, no contact will be made with either of the adjusting screws *D* and *E*; if the throw is as it should be, contact will be made with the screw *D*, and the green lamp on the top of the board will flash. If the throw is too great, contact will be made with both screws *D* and *E*, resulting in the flashing of both the red and the green lamps. In the same manner, the lamps at the bottom of the board are flashed; if the diameter of the cam is too great, neither light flashes; if correct, the green light shows; and if too small, both the green and red lights show. The contact screws are made from brass carrying a copper contact point which is held out by means of a brass spring. This device is adjusted by means of a master cam which has been measured by hand and found to be correct.

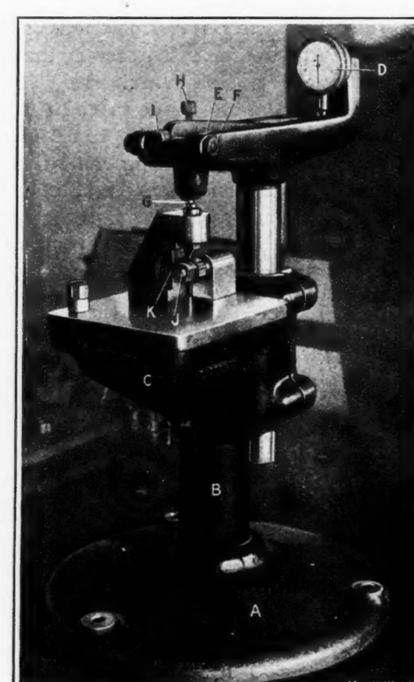


Fig. 54. Special Type of Indicating Gage for inspecting Interrupter Cams for Electric Starter

Device for Testing Electric Starter Ignition Cams

Fig. 54 shows an application of the indicating dial type of gage in conjunction with a multiplying lever for testing ignition cams for "Delco" electric starters. The indicator used gives readings to 0.0001 inch. The gage is rigidly built and consists of a base *A* in which a stand *B* is screwed that carries the measuring table *C* provided with a split box at the rear through which passes the post supporting the multiplying lever arrangement. The dial test indicator *D* is fastened to the rear bracket and is operated by a multiplying lever *E*. This is fulcrumed on adjustable pointer screws *F* and is provided with a boss at its lower surface in which a plunger *G* fits. This plunger is adjusted by a screw *H*, which, in turn, is clamped by a screw *I*. In this case, the cam to be gaged is held on a stud *J* and is brought in contact with a location point *K*. Previous to testing the work, the gage is set at zero by means of a master. The limits on this work are ± 0.0005 inch.

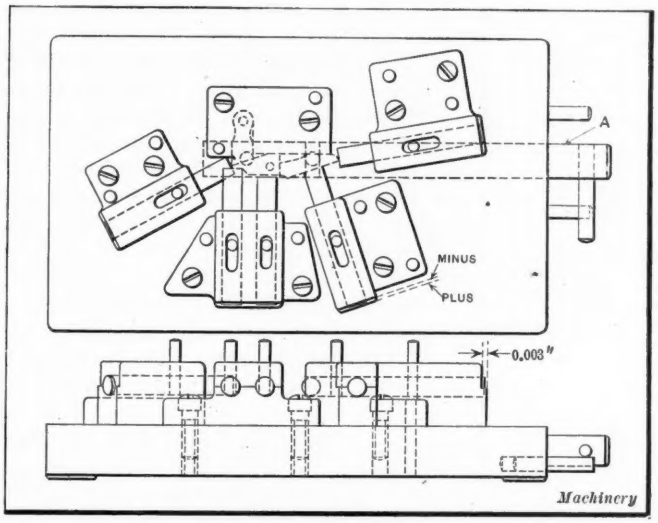


Fig. 55. Flush-pin Type of Gage for inspecting Work on the Ordinate Principle

Ordinate System of Gaging

As was explained in connection with the first installment of this article in the November number of MACHINERY, irregular-shaped parts are generally gaged by means of profile templets, the work being inspected by holding it in contact with the templet and up to the light. Of course, a very small variation in the work from the gage can be detected by the rays of light between the two pieces, but there is no definite means of determining just what this variation is. Consequently, the templet system is not satisfactory for interchangeable manufacture, as the discrepancies in the work are not measurable.

The type of profile gage used is governed largely by the shape and character of the work. In gaging cylindrical work, a profile gage called a "receiver gage" is generally employed. In this case the gage is bored, reamed and lapped to the shape of the work and is then slabbed off so that the hole in the gage is exposed; then when the work is inserted, its outline can be compared with that of the gage. The most common form of templet, as previously mentioned, is made from sheet steel and is filed down and ground on the measuring side to a knife-edge similar to that used on a straightedge. When the work to be measured has several shoulders or irregularities of outline, it is necessary, of course, that the gage be held parallel with the axis of the work if it is cylindrical in shape. There are other objections to the templet system, and in up-to-date manufacturing plants a templet is used as sparingly as possible.

By the ordinate system of gaging, a piece of irregular outline is gaged at all the principal points for the desired measurements by means of either one of two systems. One system employs the flush-pin principle and the other the dial test indicator. The system used depends, of course, on the number of surfaces to be gaged and the convenience with which these surfaces can be approached. Fig. 55 shows a simple method of gaging an irregular-shaped piece. In this case the flush-pin principle can be adopted because of the comparatively simple outline of the piece. These flush-pins are held in separate blocks fastened to a base, and the axis of the flush-pin is located at right angles to the surface to be gaged.

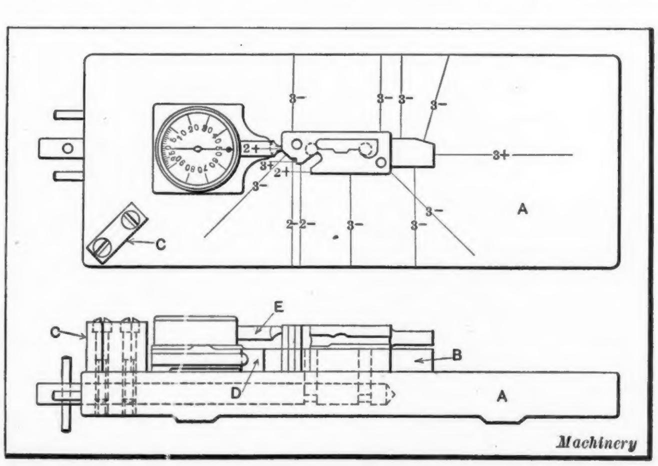


Fig. 56. Dial Indicator for inspecting Irregular Work on the Ordinate Principle

The rear end of the bracket carrying the flush-pin is provided with a plus and minus limit step. In use, the flush-pins are pushed back to insert the work in the holder, and are then pushed forward to ascertain whether the work has been machined properly or not. The test consists in comparing, by the sense of touch, the positions of the ends of the flush-pins with relation to the steps on the rear ends of the holders. A simple ejecting mechanism is used in connection with this gage; it consists of a rod *A* passing through the body of the plate and carrying two eccentrics. These work against pins held in the base that are forced upward by the eccentrics to eject the work from the dowel-pins on which it is held. Two pins in the end of the gage block act as stopping points for this rod.

Another type of gage working on the ordinate principle is shown in Fig. 56. In this case, as it will be noticed, the dial test indicator principle is employed because the points that must be measured are not accessible with the flush-pin type. The construction of this gage is comparatively simple; it consists chiefly of a base *A* carrying a hardened and lapped master block *B* which is of the same shape as the work and is hardened, ground and lapped to the mean dimensions of the work. This block is provided with close-fitting dowel-pins which are made to fit the locating holes in the work to be gaged. In the lower left-hand corner of the gage is a block *C*, which is used for setting the block *D* and spindle *E* of the dial test indicator in line with each other. The surface of this block is hardened, ground and lapped, and is at right angles to the surface of the plate. As will be noticed, lines are drawn from the points where the gaging is to be done, and opposite these lines are numbers. These numbers indicate the limits in thousandths of an inch provided on the work. For instance, 3 — means that at this point the piece can be 0.003 inch less or smaller than the master by which it is being compared.

Fig. 57. Indicating Gage for testing Pressure of Gas Engine Valve Lifter Springs

In using this gage, the block carrying the dial test indicator is swung around and the dial test indicator spindle and measuring end of the block are brought in contact with the setting block *C*. The bezel of the dial test indicator is then rotated so that the needle points to zero. The gage is then swung around and brought in contact with the work. Index

points are marked on the rear and front ends of the block *D* so that these are brought in line with lines on the plate *A*. Then the block *D* is brought in contact with the master, and the spindle of the dial test indicator in contact with the work, the resulting readings being taken off on the indicator. The indicator and block which are fastened to each other can be moved around to any point on the work and the variations between the work and the master can be read off in thousandths of an inch. The advantage of this system over the templet system is evident, in that it gives a direct reading and indicates to the inspector just how many thousandths inch the work varies from the required size.

Dial Indicators for Testing Pressure

The dial indicator is used to a large extent for testing pressure in the inspection of springs that must be capable of delivering the required pressure when compressed a certain amount. The application of the dial indicator to this work is shown in Fig. 57. This illustration shows a special fixture used in testing the pressure exerted by conical valve springs for gas engines. The fixture consists principally of a regular scale dial, which is attached to a base *A* having an upright *B*. This upright carries a spindle which is operated by a rack and pinion through the turnstile *C*, the distance that the spring is compressed being determined by the stop *D*, which comes in contact with a pin on the top of the fixture. The spring being tested is compressed about 1½ inch—the compression it has in the gas engine—and must show a pressure of 58 pounds on the dial.

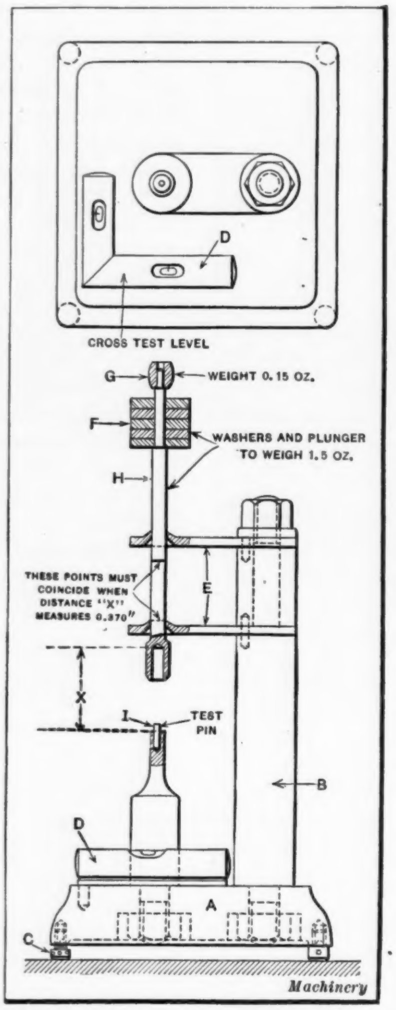


Fig. 58. Indicating Gage for testing Compressive Strength of Springs used in Combination Time and Percussion Fuses

Device for Testing Time Fuse Percussion Restraining Springs

A much more delicate instrument than that illustrated in Fig. 57 is shown in Fig. 58. In this case the device is used for testing the pressure of percussion restraining springs used in combination time and percussion fuses. In construction, it consists of a base *A* carrying an upright *B*. The base *A* rests on four feet *C*, which are capable of being adjusted so that the instrument can be brought to a parallel plane, this being determined by means of the cross-level *D*. Post *B* carries two plates *E*, which support the spindle carrying the washers *F* and *G*. These plates are countersunk so that only a knife-edge bearing is provided to contact with the plunger. The total weight of washers *F* and plunger *H* is 1.5 ounce, whereas the "limit weight" *G* is 0.15 ounce.

The spring to be tested is placed on test pin *I*, the spindle *H* meanwhile being held up by hand. The spindle is then allowed to drop and compress the spring, and if it is correct, the points marked must coincide when the distance *X* is 0.370 inch. If the weight of *F* and the spindle is not sufficient to give this reading, the limit weight *G* is added; if this makes the distance *X* correct, then the spring is O.K.; if not, it is too stiff. If the distance *X*, of course, is less than 0.370 inch when weight *G* is not on the spindle, then the spring is too weak.

Indicating Gage Depending on the Sense of Hearing

As has been previously mentioned, indicating gages depend on the sense of touch, sight and hearing for their operation. Those depending on the sense of hearing are generally of the electrical type, and an example of a gage employing this principle is shown in Fig. 59. This gage is employed for testing the closing pressure of piston rings. Piston rings have been tested for closing pressure by many other devices, all of which have been more or less satisfactory. It is generally known that a piston ring which does not possess the required amount of tension does not lie in close touch with the walls of the cylinder all around, and hence gas is allowed to leak past and compression is lost. It is therefore desirable to know if the rings have sufficient tension before they are inserted in the piston, and the gage in Fig. 59 determines this satisfactorily.

It consists chiefly of a cast-iron plate *A* machined on its top surface to provide two ribs *B* that are nicely finished so that the rings can be slipped along them without undue friction. Fastened to one side of the fixture is a bracket *C*, which is machined out on one edge; providing a step that is of a slightly greater height than the width of the piston ring being tested. Held on the other side of the cast-iron plate is a lever *D*, which is fulcrumed at the point *E* by two cone-pointed screws in the bracket *F*. At one end of the fixture, pulley *G* is attached, and running over this is a wire rope which carries the weight *H*; the size of the weight depends on the

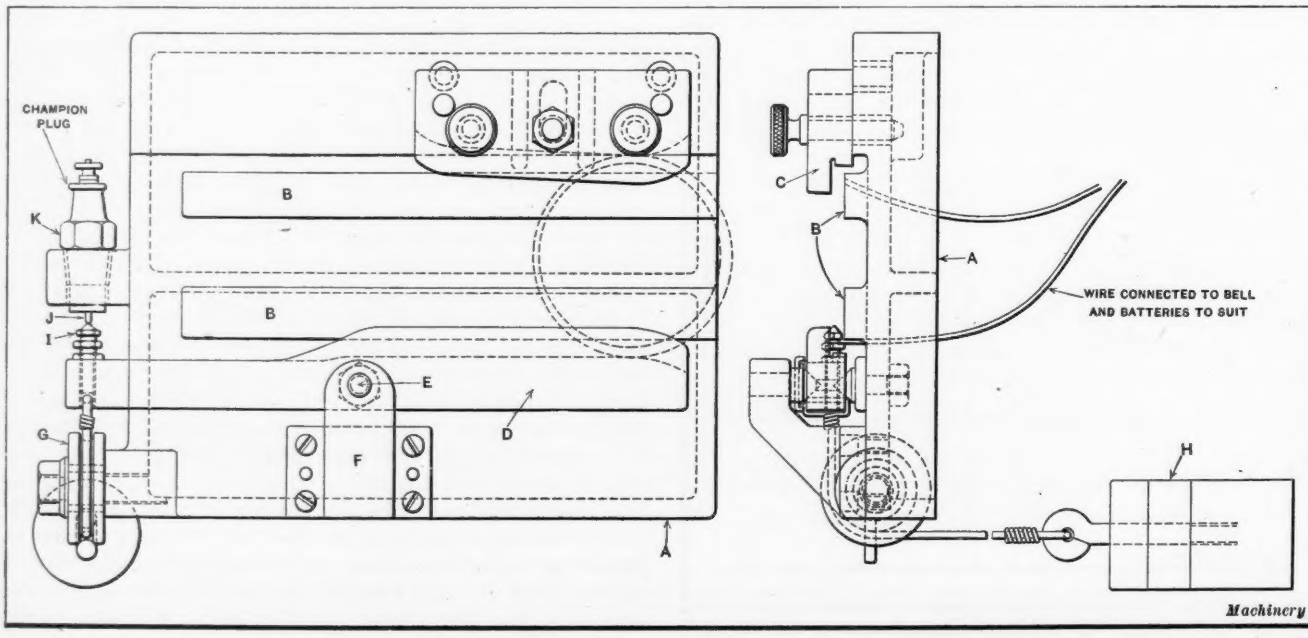


Fig. 59. Piston Ring Testing Device depending for its Reading on the Sense of Hearing

size of piston ring being tested. This wire rope, as will be noticed, is attached also to the rear end of lever *D*, which carries a contact point *I*. This contact point makes contact with the point *J* of the "Champion" spark plug *K* when the piston ring is of the desired tension. Plug *K* is connected by suitable wiring to a bell and battery in the box under plate *A*.

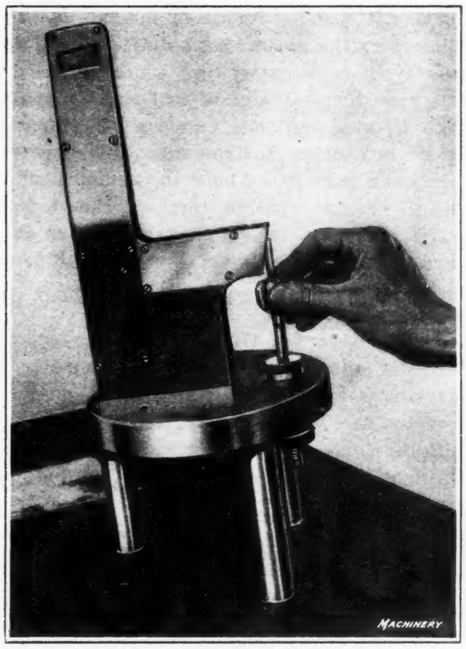


Fig. 60. Indicating Gage for testing Balls during Process of Manufacture

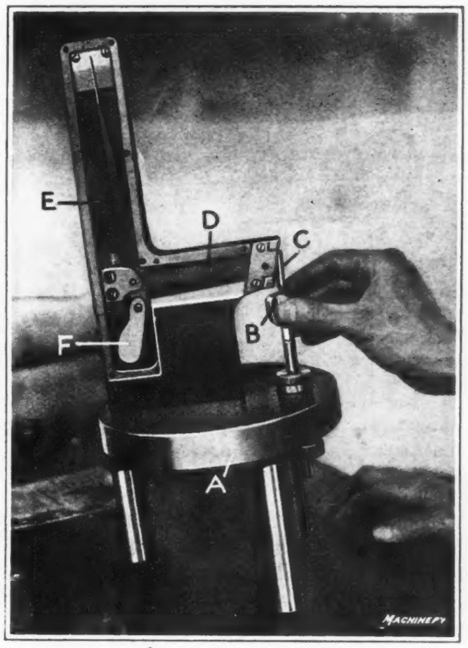


Fig. 61. Indicating Gage shown in Fig. 60 with Plate removed to show Constructional Features

In operation, the inspector lays the ring down flat on the testing surface of the plate and pulls it toward him between the fixed and movable strips *C* and *D*, respectively, with the split or saw cut exactly in the center. In pulling the ring through the fixture, if the pressure is sufficient to overcome the resistance of weight *H*, which on the Ford piston ring is 18 pounds, electrical contact is made between points *I* and *J*, and the bell in the box of the fixture is rung. If the inspector pulls the ring through the fixture without the bell ringing, then the ring does not come up to the required tension, and is consequently rejected. When this fixture was adopted in one plant it was found that previous methods had been more or less inaccurate, and anywhere from 20 to 50 per cent of the rings formerly made proved to be failures. Changes in manufacturing methods, however, reduced the number of failures from 20 to 5 and 10 per cent.

Gaging and Inspecting Balls and Ball Bearings

Aside from the manufacture of rifles and similar interchangeable work, there is probably no industry in which gaging and inspection methods are developed to a higher degree of perfection than in the manufacture of balls and ball bearings. As a rule, this industry is split up; that is, one manufacturer makes the balls and another the bearings. There are, of course, some manufacturers who make the entire product, but this is the exception rather than the rule. No other industry makes more extensive use of indicating gages than the ball and ball bearing industry, and in the following particular attention will be given to the types of gages used in this work.

Gaging and Inspecting Balls

In the gaging and inspection of balls there are two main points that must be considered. First, the ball must be spherical within certain limits, and second, it must be made to a definite diameter, also within limits. The manufacturing limits to which the balls are made depend entirely, of course, on the use to which the balls are put. For high-grade balls they must be held to within a limit of 0.00005 inch of being perfect spheres, and must not vary more than 0.00005 inch in diameter. For bicycles, hardware and similar work, the manufacturing limits, of course, can be considerably wider. In the following, however, attention will be directed particularly to the gages used in making high-grade balls.

During the process of manufacture the balls are gaged to see that the grinding or lapping machines are working properly. Figs. 60 and 61 show a special gage developed by the Hoover Steel Ball Co. of Ann Arbor, Mich., for this work. Referring to Fig. 61, which shows the construction of the gage more clearly, it will be noticed that it is of the adjustable type and is provided with two anvils, one of which is adjusted by means of a screw held in place by clamping nuts. The gage consists principally of a plate *A* mounted on three feet, the rear one of which is shorter than the other two, so that the gage is inclined at a slight angle. The ball to be gaged is shown held in the nest *B*, and the gage is so inclined that the ball always rests in the rear of this nest, so that its axis is parallel or in line with the two gaging points.

The upper and lower anvils are provided with diamond gaging points held in brass holders. These diamonds are so mounted that a flat face is presented to the ball surface to be gaged. The multiplying lever principle is used here in the ratio of 150 to 1, so that for variations of 0.0001 inch in the ball, the top point of needle *E* would move over the arc a distance of 0.150 inch. The construction of this indicating lever mechanism is as follows: Lever *D* is connected to anvil *C* and meshes with lever *E* through a rack tooth. There are no springs in this gage, and the upper anvil is kept in contact with the work by means of a weight *F* attached to the indicating needle *E*. By means of this gage it is possible to determine rapidly if the balls are being ground out of round or under diameter when in the rough state. While the wear on these diamonds is very slight, it is nevertheless necessary to be certain that the instrument is measuring correctly, and at certain intervals the indicating needle is set by means of a master ball. The adjusting screw holding the lower anvil is adjusted the required amount.

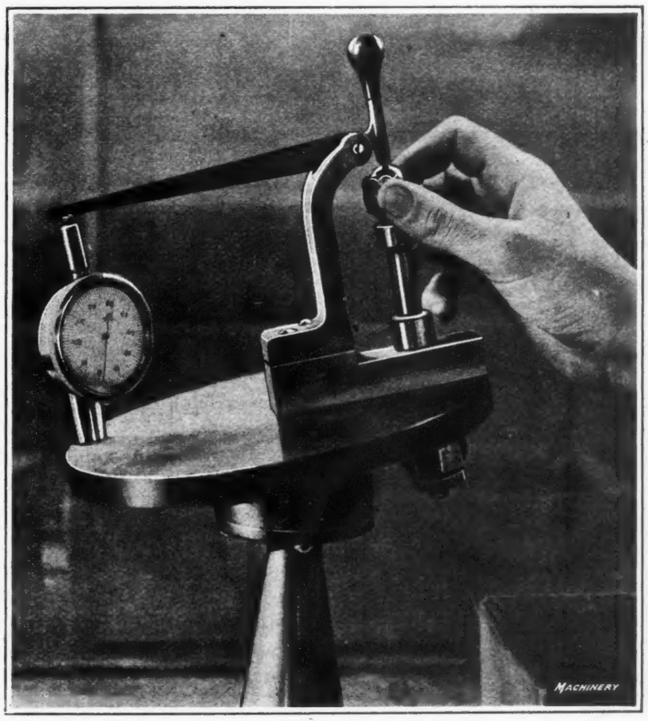


Fig. 62. Indicating Gage of Dial Type in Combination with Multiplying Lever for testing Balls over ⅝ Inch Diameter

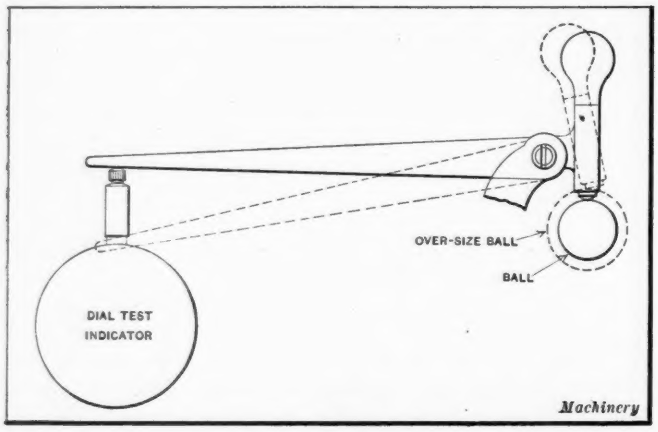


Fig. 63. Diagram illustrating Limitations of Multiplying Lever Type of Gage

Indicating Gage for Inspecting Finished Balls

After the balls come from the grinding and lapping departments, the first inspection consists in looking them over to see that they are free from pits, scale, bands, dents, tool marks, etc. This is done on the smaller sizes of balls, and particularly on those up to ¾ inch in diameter, by rolling the balls on a glass plate. A ball that is not perfectly spherical will not roll straight, but will wobble from side to side. Balls over ⅝ inch in diameter are inspected by means of the indicating gage shown in Fig. 62. As will be seen from this illustration, this consists of a dial gage combined with a multiplying lever mounted on a plate held on a stand which is set at an angle so that the ball being gaged always lies at the back surface of the pocket in which it is retained. The lower and upper anvils carry black diamond or quartz, the flat surfaces of which are presented to the ball. The multiplying lever is in the ratio of 10 to 1, and as the indicator normally reads to 0.001 inch, this multiplication makes it possible to obtain readings to 0.0001 inch. The limit on the ball is 0.00005 inch both for roundness and diameter, so that the maximum movement of the needle for satisfactory balls would be not more than one-half the amount between any two marks on the dial.

In multiplying lever gages made on this principle, it will readily be seen, by referring to Fig. 63, that very wide variations in diameter cannot be accurately indicated. The reason for this is that the length of the arm of the multiplying lever changes as the measuring point is moved up or down. Consequently, it is essential that a master ball be used for setting this gage for each size of ball to be gaged, and then that the gage be used only as a means of comparison and not as a direct measuring instrument. Girls operating these instruments can gage 10,000 balls in ten hours, or 1000 balls an hour, and determine whether the ball is out of round, within the limits for diameter, or has any other imperfections which have passed the notice of the previous inspectors.

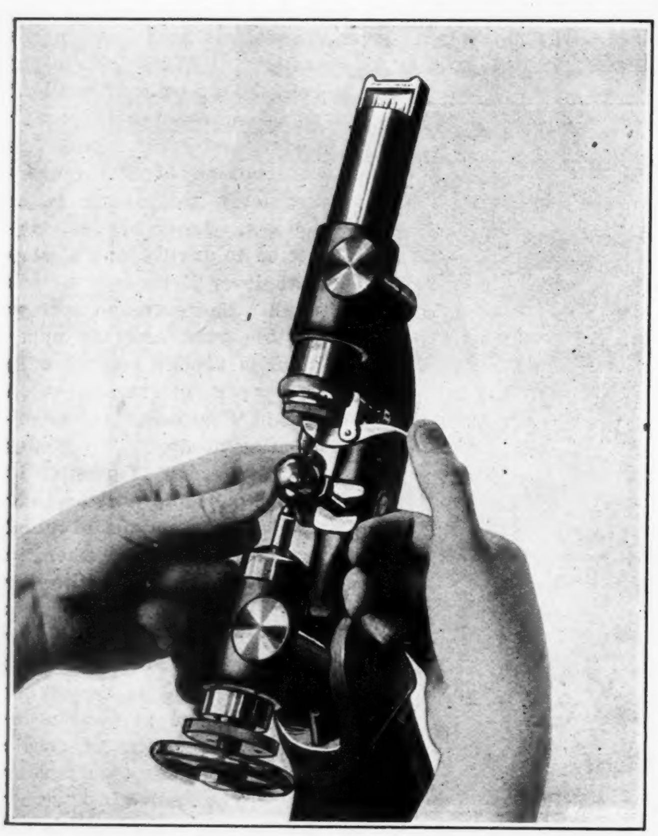


Fig. 64. Hirth Minimeter used for testing Diameter of Finished Balls

Hirth Minimeter for Gaging Balls

Fig. 64 shows a Hirth minimeter for inspecting balls for diameter and spherical form. It consists of a special stand carrying a lower anvil which is adjustable as shown, a support for the ball to locate it so that its axis comes in line with the upper and lower anvils, and an arm in which the minimeter proper is retained. The top measuring anvil of the minimeter is lifted by means of the finger as shown, and when the ball is inserted all external pressure is removed. This instrument is constructed so that readings as fine as 0.00005 inch are obtainable.

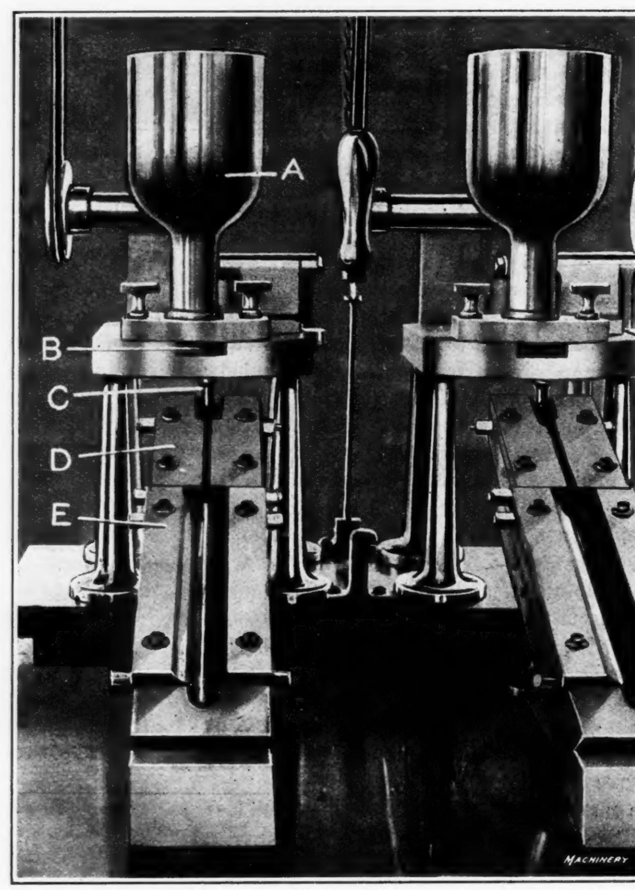


Fig. 65. Automatic Ball Gaging Machine for inspecting Balls up to ⅜ Inch Diameter

Automatic Ball Gaging Machines

High-grade balls under ⅝ inch in diameter are gaged for diameter by automatic ball gaging machines, two types of which are shown in Figs. 65 and 66. The machine shown in Fig. 65 is used for gaging balls up to ⅜ inch in diameter and comprises a hopper for holding the balls, and a slide through which they roll to be gaged. The measuring portions of this slide consist of two straightedges, the space between the edges of which gradually increases in width as the slide extends from the hopper. Passing beneath the hopper is a slide which is agitated by a rack and segment gear, operated by an eccentric motion. The balls to be gaged are dumped into hopper *A* and carried forward to the delivery spout by means of a slide *B*. Slide *B* carries one ball forward at a time, drops it through spout *C* and into slide *D*. Here the distance between the two slides is about 0.005 inch smaller than the smallest diameter of the balls to be gaged. The

balls then roll along between slides *D* until they come to the straightedges *E*. These straightedges are set to allow the maximum tolerance on the ball, and the center portion of the straightedge gives the size of ball actually demanded.

The position to which these straightedges is set is determined entirely by the limits required on the balls. If the balls must be held within very close limits, then the amount of variation in the taper of the straightedges is slight. Sometimes they are set so that a difference of 0.005 inch in diameter will be measured from one end to the other. As the balls roll down these slides due to the action of gravity, the angle to which they are set being about 20 degrees from the plane of the table, they drop through the slide at the point where the distance between the two straightedges is slightly greater than the diameter of the ball. As they drop through, they are separated by tubes which enter the various drawers in the cabinet located beneath the table top. When these drawers are full, they are removed and the balls taken out and put in proper boxes according to the grading determined by the machine.

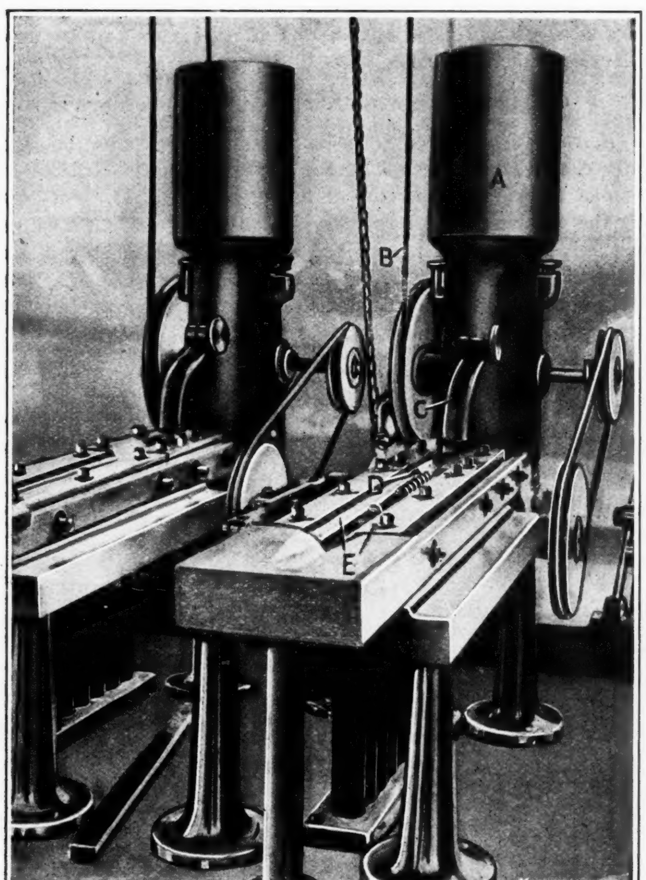


Fig. 66. Automatic Ball Gaging Machine for inspecting Balls up to ⅝ Inch Diameter

Another type of automatic ball gaging machine is shown in Fig. 66. This is used for gaging balls up to ⅝ inch diameter. In this case the slides are set almost parallel with the table, and the balls are carried between the straightedges by means of an agitator which comes up and lifts them from the surface of the straightedges. The top surface of the agitator is at an angle of about 5 degrees, and when the agitator rises the balls roll along it until they drop through between the straightedges. This particular machine is provided with eight compartments, and the variation between each compartment is 0.0001 inch. For gaging, the balls are placed in the hopper *A*, inside of which is an agitator operated by the belt *B*. This distributes the balls so that they come out of the spout *C* one at a time and drop into slide *D*. From this they are carried on by the agitator onto the straightedges *E* until they drop down into the required compartment.

Gaging and Inspecting Ball Bearing Race Rings

The gaging of ball bearing races is naturally work of refinement, and as far as the race rings are concerned interchangeability is possible. This is not true, however, as regards the assembling of the balls in the races. The reason for this is that the balls do not all come the same size, the limits varying from + 0.0001 inch to — 0.0001 inch. The ball bearing manufacturers claim that if they wanted to get all balls the same size they would have to pay a much higher price for them. Consequently, they select balls to fit the races. This is not a disadvantage, however, because if a ball in a bearing should break, it would leave the raceway in the rings in such a condition that they would either have to be reground or replaced. The limits on the race rings, however, are held very close. For instance, on the hole in the inner race which fits on the shaft the limits are + 0.0002, — 0.0004 inch. For the outside diameter of the outer race ring the limits are + 0.0004, — 0.0008 inch. In the ball bearing raceways the variation is as great as 0.0003 inch, and by selecting the proper balls the differences in races can be taken care of. The limits on the hole of ball thrust bearing races are + 0.0002 to — 0.0004 inch. For the outside diameter the limits are + 0.0006 inch, — 0.0012 inch, according to size. The height of single thrust bearings is + 0.002 inch, and the height of double-acting thrust bearings + 0.004 inch. Tables I and II give tolerances for ball and roller bearings, respectively, as established by the S. A. E. In the case of ball bearings, only the light series is listed; and in the case of roller bearings, only the narrow series is given. The tolerances, however, on the medium and heavy ball bearings and medium and wide roller bearings are the same.

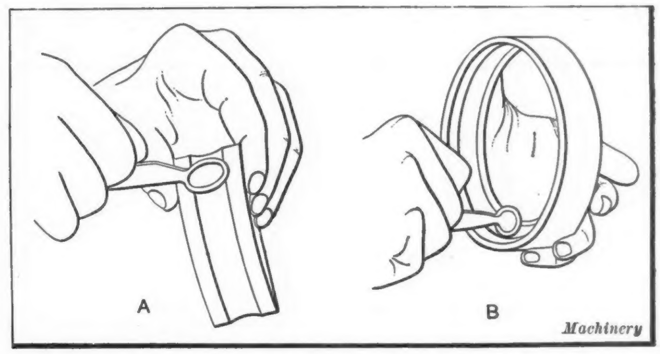


Fig. 67. Use of Templet for inspecting Raceways in Outer and Inner Ball Bearing Rings

For gaging ball bearings when machining, the micrometer caliper is extensively used for measuring all outside dimensions, and for internal measurements plug gages or three-point indicating gages are generally adopted. The plug gage has been found unsatisfactory for gaging ball bearing race rings. The reason for this is that the operator does not know how much material remains to come off, and consequently is working in the dark until he reaches the "Go" dimension on the gage. The result is that all grinding machine operators prefer to use some sort of indicating gage which gives them latitude. One prominent ball bearing manufacturer has de-

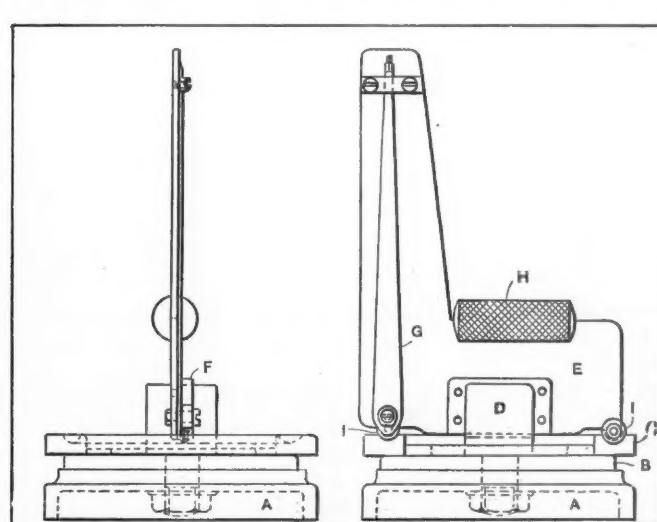
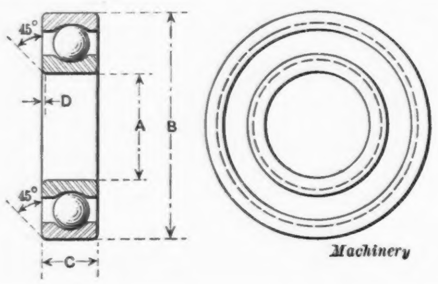


Fig. 68. Special Indicating Device for testing Raceways in Thrust Bearing Race Rings

TABLE I. S. A. E. STANDARD SIZES AND TOLERANCES FOR BALL BEARINGS (LIGHT SERIES)



Ball Bearing Number	Bore of Inner Race Ring			Diameter of Outer Race Ring		
	Bore A, Inches	Tolerance, Inches		Diameter B, Inches	Tolerance, Inches	
		Plus	Minus		Plus	Minus
200	0.39370	0.0002	0.0004	1.18110	0	0.0006
201	0.47244	0.0002	0.0004	1.25984	0	0.0006
202	0.59055	0.0002	0.0004	1.37795	0	0.0006
203	0.66929	0.0002	0.0004	1.57481	0	0.0006
204	0.78740	0.0002	0.0004	1.85040	0	0.0006
205	0.98425	0.0002	0.0006	2.04725	0	0.0008
206	1.18110	0.0002	0.0006	2.44095	0	0.0008
207	1.37795	0.0002	0.0006	2.83465	0	0.0008
208	1.57481	0.0002	0.0006	3.14962	0	0.0008
209	1.77166	0.0002	0.0006	3.34647	0	0.0008
210	1.96851	0.0002	0.0006	3.54332	0	0.0008
211	2.16536	0.0002	0.0006	3.93702	0	0.0008
212	2.36221	0.0002	0.0006	4.33072	0	0.0008
213	2.55906	0.0002	0.0006	4.72443	0	0.0008
214	2.75591	0.0002	0.0006	4.92128	0	0.0008
215	2.95277	0.0002	0.0006	5.11813	0	0.0008
216	3.14962	0.0002	0.0006	5.51183	0	0.0008
217	3.34647	0.0002	0.0007	5.90554	0	0.0012
218	3.54332	0.0002	0.0007	6.29924	0	0.0012
219	3.74017	0.0002	0.0007	6.69294	0	0.0012
220	3.93702	0.0002	0.0007	7.08664	0	0.0012
221	4.13387	0.0002	0.0007	7.48035	0	0.0012
222	4.33072	0.0002	0.0007	7.87405	0	0.0012

Ball Bearing Number	Width of Both Race Rings			Corners D[1] on Outer Race and Bore of Inner Race, Inch	Eccentricity Tolerance, Inches	
	Width C, Inches	Tolerance, Inches			Inner Race Ring	Outer Race Ring
		Plus	Minus			
200	0.35433	0	0.0020	0.040	0.0008	0.0012
201	0.39370	0	0.0020	0.040	0.0008	0.0012
202	0.43307	0	0.0020	0.040	0.0008	0.0012
203	0.47244	0	0.0020	0.040	0.0008	0.0012
204	0.55118	0	0.0020	0.040	0.0008	0.0012
205	0.59055	0	0.0020	0.040	0.0008	0.0012
206	0.62992	0	0.0020	0.040	0.0008	0.0012
207	0.66929	0	0.0020	0.040	0.0008	0.0012
208	0.70866	0	0.0020	0.080	0.0008	0.0012
209	0.74803	0	0.0020	0.080	0.0010	0.0016
210	0.78740	0	0.0020	0.080	0.0010	0.0016
211	0.82677	0	0.0020	0.080	0.0010	0.0016
212	0.86614	0	0.0020	0.080	0.0010	0.0016
213	0.90551	0	0.0020	0.080	0.0010	0.0016
214	0.94488	0	0.0020	0.080	0.0010	0.0016
215	0.98425	0	0.0020	0.080	0.0010	0.0016
216	1.02362	0	0.0020	0.120	0.0012	0.0018
217	1.10236	0	0.0020	0.120	0.0012	0.0018
218	1.18110	0	0.0020	0.120	0.0012	0.0018
219	1.25984	0	0.0020	0.120	0.0012	0.0018
220	1.33858	0	0.0020	0.120	0.0012	0.0018
221	1.41732	0	0.0020	0.120	0.0012	0.0018
222	1.49607	0	0.0020	0.120	0.0012	0.0018

[1] A chamfer of 45 degrees ground true with the bore and outside diameter is recommended.

vised a three-point indicating gage for use on the grinding machine for internal work which is used entirely by the machine operators and has been found to give satisfactory results.

For external grinding, snap gages are seldom used for the reason previously given. Attempts have been made by one manufacturer to replace the micrometer caliper with a dial test indicating gage. This proved unsatisfactory, however, owing to the excessive fluctuations to which the needle is subjected when it is necessary to slide the gaging point over the work. On a dial test indicator which is made to read to 0.0001 inch, very little irregularity in the surface of the work causes a considerable movement of the needle, and as there is no brake or effective means of holding it, it is difficult to use this type of gage for snap work. Consequently, it is the rule in practically all plants making ball bearing race rings to use micrometer calipers in the manufacturing department. The inspectors, of course, are furnished with plug and snap gages of the limit type.

Plug gages for ball bearing races must be made light, so as not to fatigue the inspector. With a plug gage, say 3 inches in diameter, made from solid tool steel, the weight is objectionable, and several manufacturers reduce the weight of large plug gages by making the gaging part in the form of a ring which is held on an aluminum core. The aluminum core, of course, is extended to form the handle and is knurled as usual. In some plants plug gages that have become worn are annealed and turned down to the next size. They are then hardened, ground and lapped, and in this way can be used a large number of times.

Gaging Raceways in Annular Ball Bearing Rings

The raceways or grooves in ball bearing rings must be carefully checked. The shape of the curve is usually checked by templet gages, as illustrated at *A* and *B* in Fig. 67. For testing the diameter of the raceway in the inner and outer rings, respectively, various means are employed, the most common being that in which three balls are used to determine the correct depth. Another method makes use of a micrometer caliper having three ball points.

Gaging Raceways in Thrust Bearings

For thrust bearing race rings it is necessary, of course, that the raceway be concentric with the bore of the ring; also that

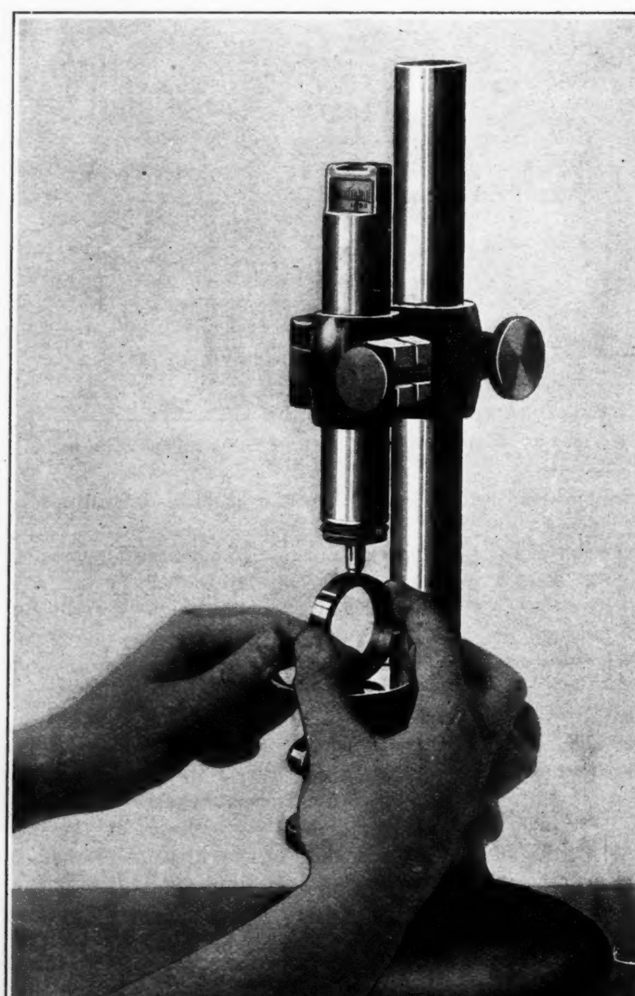
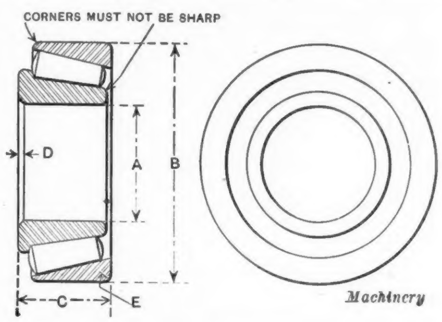


Fig. 69. Hirth Minimeter set up and in Use for testing External Diameter of Ball Bearing Race Rings

TABLE II. S. A. E. STANDARD SIZES AND TOLERANCES FOR ROLLER BEARINGS (NARROW SERIES)



Roller Bearing Number	Bore of Inner Cone			Diameter of Outer Cone			Width of Assembled Bearing			Minimum Chamfer D, Inches	Radius E, Inches	Eccentricity Tolerance, Inches	
	Bore A, Inches	Tolerance, Incnes Plus	Tolerance, Incnes Minus	Diameter B, Inches	Tolerance, Inches Plus	Tolerance, Inches Minus	Width C, Inches	Tolerance, Inches Plus	Tolerance, Inches Minus			Plus	Minus
RM-304	0.78740	0.0002	0.0006	2.04725	0	0.0008	7/8	0.020	0.020	0.040	0.040	0.0008	0.0012
RM-305	0.98425	0.0002	0.0006	2.44095	0	0.0008	1	0.020	0.020	0.040	0.040	0.0008	0.0012
RM-306	1.18110	0.0002	0.0006	2.83465	0	0.0008	1 3/16	0.020	0.020	0.080	0.080	0.0008	0.0012
RM-307	1.37795	0.0002	0.0006	3.14962	0	0.0008	1 3/8	0.020	0.020	0.080	0.080	0.0008	0.0012
RM-308	1.57481	0.0002	0.0006	3.54332	0	0.0008	1 7/16	0.020	0.020	0.080	0.080	0.0008	0.0012
RM-309	1.77166	0.0002	0.0006	3.93702	0	0.0008	1 9/16	0.020	0.020	0.080	0.080	0.0010	0.0016
RM-310	1.96851	0.0002	0.0006	4.33072	0	0.0008	1 3/4	0.020	0.020	0.080	0.080	0.0010	0.0016
RM-311	2.16536	0.0002	0.0006	4.72443	0	0.0008	1 15/16	0.020	0.020	0.080	0.080	0.0010	0.0016
RM-312	2.36221	0.0002	0.0006	5.11813	0	0.0008	2 1/8	0.020	0.020	0.080	0.080	0.0010	0.0016
RM-313	2.55906	0.0002	0.0006	5.51183	0	0.0008	2 5/16	0.020	0.020	0.120	0.120	0.0010	0.0016
RM-314	2.75591	0.0002	0.0007	5.90544	0	0.0012	2 1/2	0.020	0.020	0.120	0.120	0.0010	0.0016
RM-315	2.95277	0.0002	0.0007	6.29924	0	0.0012	2 11/16	0.020	0.020	0.120	0.120	0.0010	0.0016
RM-316	3.14962	0.0002	0.0007	6.69294	0	0.0012	2 11/16	0.020	0.020	0.120	0.120	0.0012	0.0018
RM-317	3.34647	0.0002	0.0007	7.08664	0	0.0012	2 7/8	0.020	0.020	0.120	0.120	0.0012	0.0018
RM-318	3.54332	0.0002	0.0007	7.48055	0	0.0012	2 7/8	0.020	0.020	0.120	0.120	0.0012	0.0018
RM-319	3.74017	0.0002	0.0007	7.87405	0	0.0012	3 1/16	0.020	0.020	0.120	0.120	0.0012	0.0018
RM-320	3.93702	0.0002	0.0007	8.46460	0	0.0012	3 1/4	0.020	0.020	0.120	0.120	0.0012	0.0018

it be of the correct depth and the proper radius. A satisfactory indicating gage for testing race rings is shown in Fig. 68; the race ring being tested is that used on the main drive shaft of an automobile. As shown, the gage consists of a cast-iron stand *A* in which a hardened and ground steel ring *B* is held. The top part of this ring is made a good fit for the inside diameter of the ball bearing race ring *C*. A stud *D* held to the base by a nut as shown, is slotted to receive the gage plate *E*. Stud *D* is hardened and ground and plate *E* has a reinforced plate *F* held to it by rivets, the latter being hardened and ground and made a good fit in the slot in the stud. The fulcrum of the pointer or needle *G* is so placed that any variation in the work is magnified twenty-five times at the point where the reading is taken. A knurled handle *H* is fastened to the gage for convenience in holding.

In operation, the work is slipped over the ring *B* of the gage, as shown; then the gage plate *E* is placed in the slot in stud *D*, and the gaging knife-edge rollers *I*, which in this case do not rotate but are held rigidly to the frame, are placed in the ball race groove. The position of the indicating point of the needle is then noted to see if the race is of the required diameter. A limit of 0.001 inch is allowed on the diameter of the ball race groove, which is 4.125 inches. The base of this gage is fastened to a frame, not shown, which is of sufficient height to bring the ring to be gaged in line with the operator's vision.

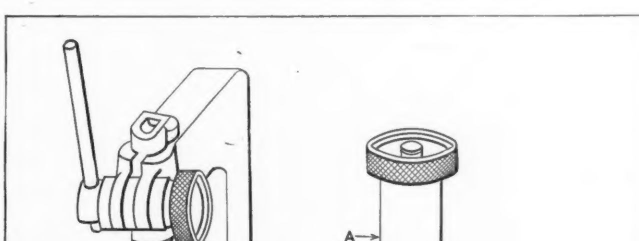


Fig. 70. Special Inspecting Fixture for testing Side Wobble and Concentricity of Assembled Ball Bearings

Testing Diameters of Inner and Outer Race Rings

As has been previously mentioned, the outer diameters of the inner and outer race rings are generally inspected by snap gages or indicating gages. Fig. 69 shows the Hirth minimeter being used for this work; the graduated scale on this minimeter is such as to give readings to 0.0001 inch, and it has been found very satisfactory for work of such refinement. For gaging the interior or hole in the outer and inner races, plug gages are sometimes used, but a more satisfactory gage is shown in Fig. 28 in the previous installment of this article. This shows a Hirth minimeter with a special attachment by means of which it is possible to tell whether the diameter is correct or not, and whether the hole is out of round, tapered, etc.

Testing Concentricity of Ball Bearings

In order to determine if the ball bearing will run true within the required limits, the cone or center race is tested for wobble or concentricity. Usually this is done by supporting the inner ring or cone on an arbor and using an indicating gage similar to that illustrated in Fig. 70, where a completed ball bearing is shown being tested. In testing a ball bearing for con-

centricity after the balls, retainers, and inner and outer races have been assembled, the inner race is forced by hand carefully onto a hardened and ground arbor. This is then placed between centers, as shown in Fig. 70, and the carrier *A* holding a Hirth minimeter is brought up so that the needle stands at zero when it is brought in contact with the outer race. The outer ring is then rotated independently of the inner one, also on centers, and the amount of side wobble or concentricity is noted on the minimeter scale.

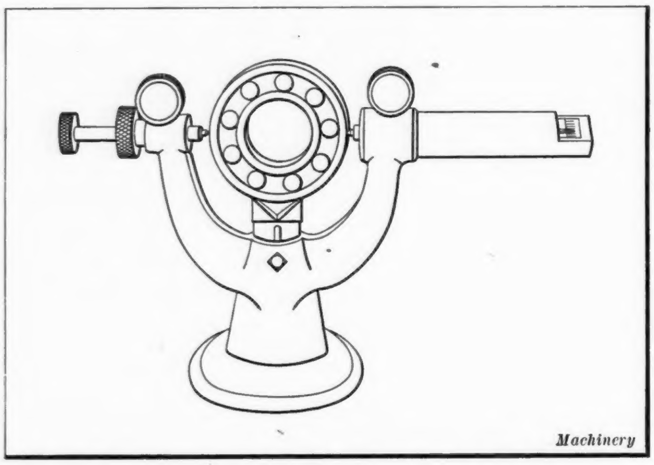


Fig. 71. Special Type of Three-point Gage using Hirth Minimeter for testing Roundness and Diameter of Assembled Ball Bearing

The amount of wobble allowed in a ball bearing depends on its size; it is usually not greater than 0.001 or 0.002 inch for large bearings, and is, of course, less than this for smaller sizes. The axial wobble or thrust, that is, the displacement of the inner race with respect to the outer, is not of such great significance as the radial wobble. Experiments in various shops have shown that a slight axial clearance does not appreciably affect the durability of the ball bearing. In general, a clearance of 0.002 or 0.003 inch may be regarded as advantageous.

Testing External Diameter of Completed Ball Bearings

A simple but satisfactory means of gaging the external diameter of a completely assembled ball bearing is shown in Fig. 71. This gage is built in the form of a snap gage and has in the middle a movable V-support, which is set in accordance with the diameter of the bearing being measured. One of the two measuring points has a coarse adjustment by means of an adjusting screw, which fits in holes 0.04 inch apart, and a fine adjustment by means of a micrometer. The measurement is taken with a Hirth minimeter, which is brought in contact with the opposite side of the ball bearing. The bearing is rotated while being tested, so that its roundness can be tested at the same time as the diameter. This particular gage is set by means of a master ring.

Box Type Inspection Fixtures

The gaging of single holes, shafts and similar work is a comparatively simple proposition as compared with the gaging of parts having a multiplicity of holes that must bear some definite relation to each other and to finished surfaces. Formerly many manufacturers depended on their jigs and fixtures to obtain the desired amount of accuracy. As will be readily recognized, however, jigs and fixtures cannot be depended upon to remain accurate for any considerable length of time, especially when they are roughly handled, and if the work that comes from these fixtures must be accurate, it is highly desirable that the fixtures be tested frequently.

Another point which must be considered is the fact that a box type of jig is likely to drill and ream work inaccurately if not kept clean by the operator. The collection of dirt in one corner of a box jig would easily throw the work out to such an extent that the holes which have to bear a certain relation to a milled surface would be located inaccurately. Consequently, the most desirable practice is to gage the work after it comes from the jig. The importance of this fact will be more fully appreciated when it is remembered that most drilling machine work is done by what might be termed inexperienced mechanics—men who know little about accurate work, and simply have sufficient knowledge to put the work in the jig, take it out again, and operate the machine.

The Dayton Engineering Laboratories Co. of Dayton, Ohio, has developed an interesting system of box gaging which is used to a large extent throughout the various manufacturing departments in its plant. This type of gage has been developed primarily in an endeavor to produce electric starting, ignition and lighting equipments on a truly interchangeable basis. In the following are described some of the gages used in this plant which incorporate interesting features.

Method of Gaging Milled Surfaces in Relation to Dowel-pin Holes

Fig. 72 shows an interesting box gaging fixture, used to determine the location of a reamed hole and milled surface on a generator end frame, in relation to the dowel-pin holes. The fixture is provided with hardened and ground dowel-pins *A* which fit in the dowel-pin holes of the work, and a hardened and ground plug *B* operated by plug *C*. When the work *D* is placed on the dowel-pins, plug *B* is raised into the hole, and if the hole is correct, the plug will pass through. If not, of course, the plug will not rise. The limits on the work are provided by having the plug the required amount smaller than the hole in the work. The milled surface on the work is inspected by means of the rotating plug gages *F* and *G*. These, as will be noticed, are each provided with two bosses, one of which is made to indicate the "Go" and the other the "Not Go" dimension. These projections are then swung past the milled surface on the work, and if the "Go" end passes by and the "Not Go" does not, the work is within the required limits. In this case, the tolerance allowed on the milled surface is 0.002 inch, and on the hole the limits are $\pm$ 0.001 inch.

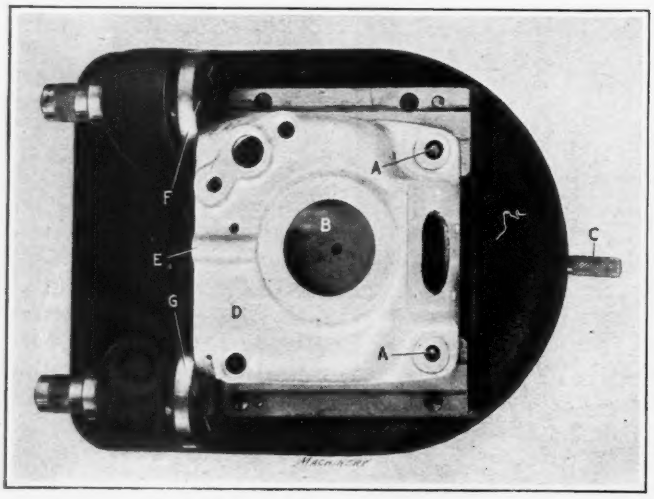


Fig. 72. Special Type of Box Gaging Fixture used for inspecting Relation of Bore to Milled Surfaces on an Electric Starter Generator Frame

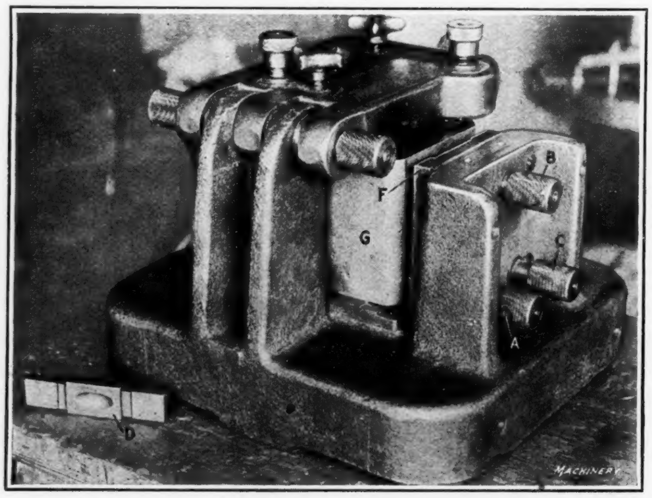


Fig. 73. Box Type of Gage for inspecting Tapped Holes and Milled Surfaces on Electric Starter Generator Frame

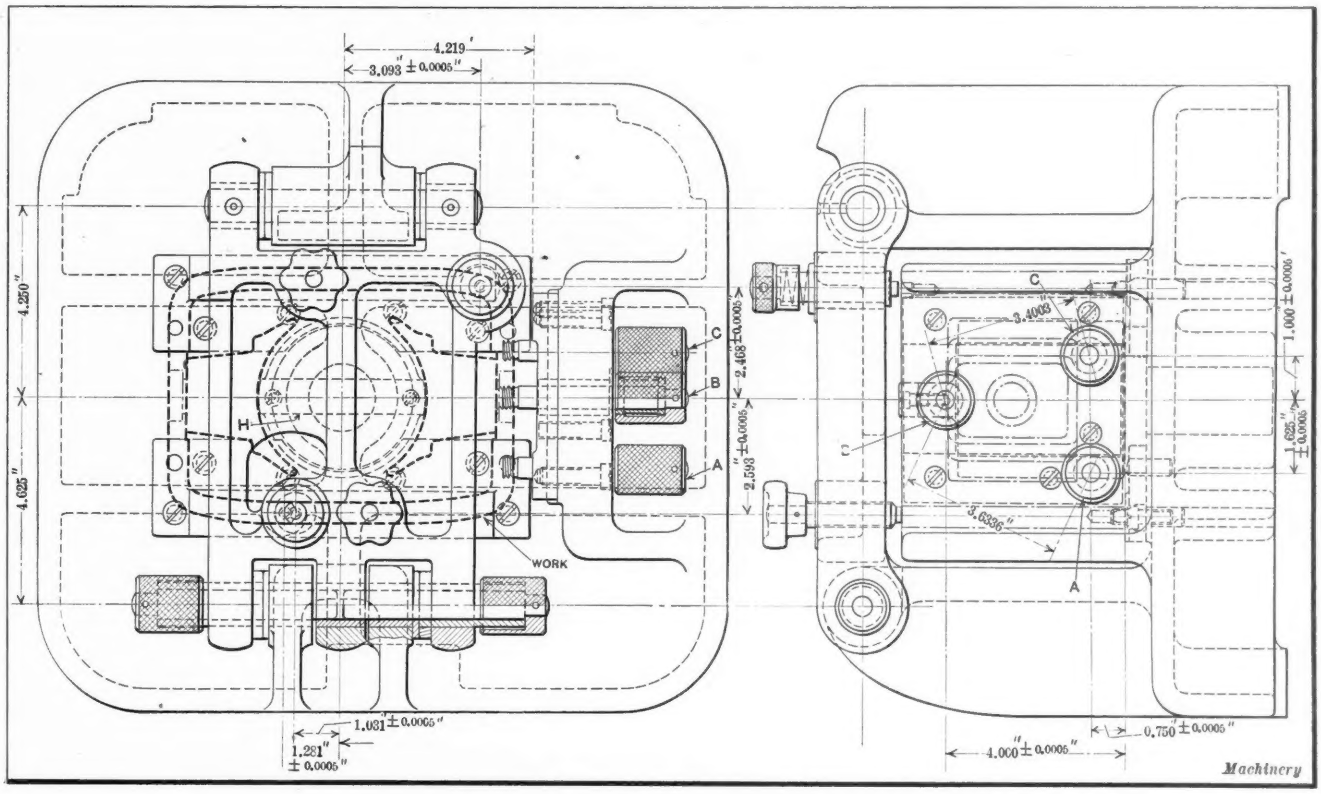


Fig. 74. Constructional Features of Gage shown in Fig. 73

Box Inspection Gage for Generator Frame

An interesting and practical application of the box type of gaging fixture is shown in Figs. 73 and 74. This gaging fixture is used for inspecting the location of the various holes in the generator frame, and is constructed along the same lines as the drilling jig used in producing the holes. The points to be gaged are three threaded holes which must bear a definite relation to the milled surface, and in addition, the milled surface must bear a certain relation to the center hole. The three holes are gaged, respectively, by the plugs *A*, *B* and *C*. The location of the milled surface is inspected by the limit gage *D*, Fig. 73, which is of the feeler type and is inserted between the hardened and ground plate *F* and the work *G*. Reference to Fig. 74 will show the variation allowed in the fixture in the location of the three tapped holes, which is ± 0.0005 inch. The limits on the work are still wider and are controlled by means of the variation between the pitch diameter of the plug gage and the threaded hole in the work. The location of the milled surface on the work in relation to the central hole, as will be noticed, also has limits of ± 0.0005 inch in the manufacture of the gage, whereas the work has a tolerance of 0.002 inch. The bore is inspected by a swinging end measuring bar *H*, Fig. 74, which is fulcrumed on a central stud and has "Go" and "Not Go" ends.

Reference to Fig. 73 will show that this gage is constructed of cast iron, and all wearing surfaces are made of tool steel or machine steel casehardened and ground. It consists primarily of a base on which a measuring surface is screwed and a swinging plate fulcrumed at the rear of the fixture and held down by means of two hardened and ground plugs. The swinging plate is provided with two clamping screws in the center and two spring plungers. The clamping screws are brought down lightly and the springs are depended upon to keep the work tightly against the lower surface of the fixture.

Generator Frame Inspection Gages

Fig. 75 shows another generator frame gaging fixture which is constructed on the same principle as that illustrated in Figs. 73 and 74. In this case, the generator is of different shape, and the fixture is shown with the lid up, exposing its interior construction. Reference to this illustration will show that the pole piece bearings are inspected by means of a swinging gage *A* having "Go" and "Not Go" ends. The bar is grasped by the inspector and is swung around past the poles to determine if they are of the correct diameter. The lid is then swung down and the feeler gage *B* used to determine if the frame is of the required length in relation to the central hole or axis. On the opposite end is a hole which must be gaged; this is done by a plug gage which is smaller than the hole in the work by an amount equal to the limits allowed.

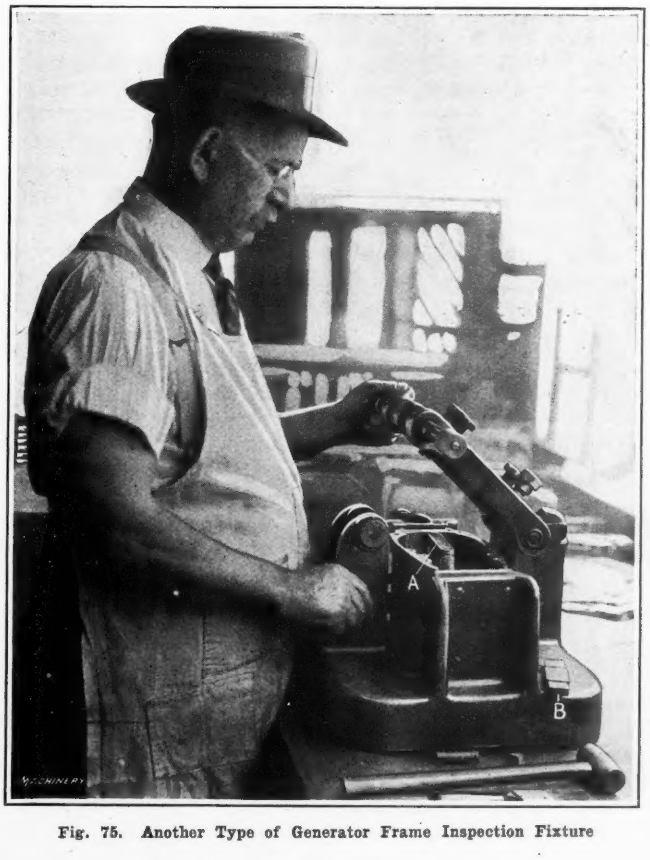


Fig. 75. Another Type of Generator Frame Inspection Fixture

Two additional gaging fixtures are shown in Fig. 76. The one to the left is built along similar lines to the generator frame gage shown in Fig. 74. This gage shows the work removed and illustrates the method of locating and gaging it. The work fits

over the stud *O*, and is provided with a slot in which plunger *A* fits. A feeler gage is then inserted between the hardened plate *B* and the work to inspect the position of this slot, as well as of the milled surface in relation to the central hole. There is a bushed hole *C* in the top cover plate through which a plug is inserted for gaging a corresponding hole in the work. The fixture is provided with gaging seats in which dowel-pins are located for centering the work. The hinge plate, as will be noticed, is bushed, and is located accurately by hardened, ground and lapped plugs.

An inspection fixture which somewhat resembles the one shown in Fig. 73 is illustrated to the right in Fig. 76. This gage is also used for inspecting a generator frame, and determines the relation of a second bored hole having two diameters at right angles to the first which is located from stud *F*. The work is located by two dowel-pins, and the central plug is raised by operating lever *G*. Reference to this fixture will show that the traverse plugs *D* and *E* are prevented from turning. These two plugs and the central one determine the relation of the center distances between the spiral gears in the generator frame, and the relation of these holes may vary more in one direction than in another. In addition, two other rotating "Go" and "Not Go" plugs *H* and *I* are used to determine the location of the milled surface. The work is held

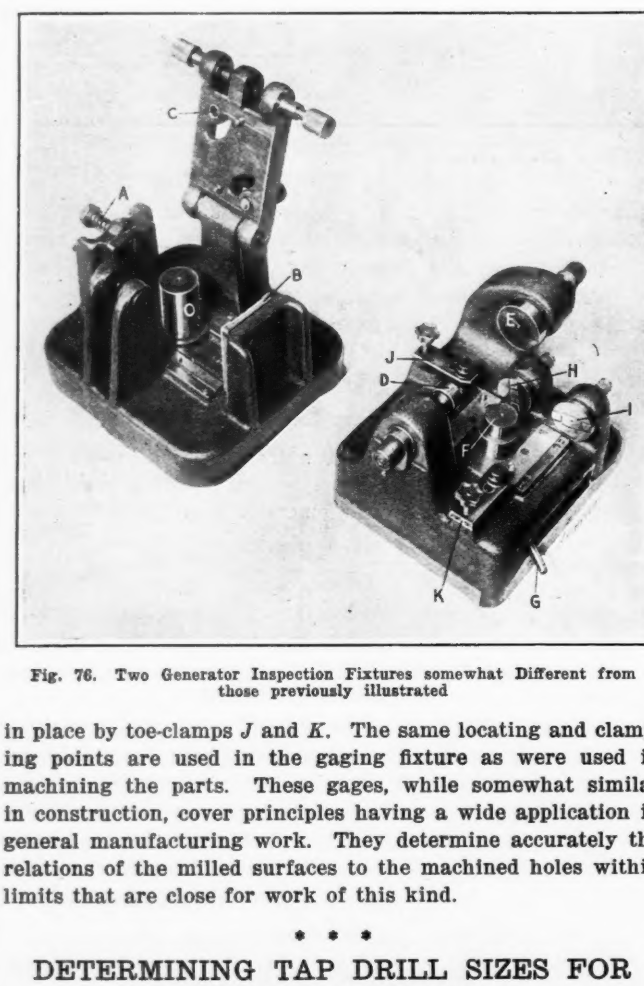


Fig. 76. Two Generator Inspection Fixtures somewhat Different from those previously illustrated

in place by toe-clamps *J* and *K*. The same locating and clamping points are used in the gaging fixture as were used in machining the parts. These gages, while somewhat similar in construction, cover principles having a wide application in general manufacturing work. They determine accurately the relations of the milled surfaces to the machined holes within limits that are close for work of this kind.

* * *

DETERMINING TAP DRILL SIZES FOR METRIC THREADS

A short time ago, the writer was required to set the tap drill sizes for a number of different pitches of metric threads, international standard. In working out the sizes, it was assumed that about 75 per cent of a full thread would give commercially satisfactory results, and with this point settled, the following steps were taken:

Let D = outside diameter of thread;
DD = double depth of thread;
RD = root diameter of thread;
TD = diameter of tap drill;
p = pitch of thread in millimeters.

$$DD = p \times 1.29904$$

and

$$RD = D - (p \times 1.29904)$$

Hence:

$$TD = D - p \times 1.29904 \times 0.75$$

Taking an example, let us assume that we wish to know the tap drill size for an international thread, 10 millimeters in diameter with 1.5 millimeter pitch. Applying the formula:

$$TD = 10 - 1.5 \times 1.29904 \times 0.75$$

$$TD = 8.53858$$

The nearest metric drill which can be obtained for this is 8.5 millimeters.

After figuring out a number of tap drill sizes by this formula, it was apparent that $p \times 1.29904 \times 0.75$ in all cases was almost the same as p; and as metric drills can be obtained in millimeter sizes and tenths of millimeters, a small variation would be permissible. An inspection of the sizes obtained made it evident that all this multiplication to obtain tap drill sizes was unnecessary and that $TD = D - p$, or, taking the same example as that given previously, $10 - 1.5 = 8.5$ tap drill.

No simpler formula can be devised for tap drill sizes than that given, as the sizes can be determined by inspection. The same formula can be applied to tap drills for the U. S. form of thread. For example, taking a ¾-inch diameter thread with ten threads per inch (0.100 inch pitch), we would have $0.750 - 0.100 = 0.650$ inch *TD*. The size commonly used for this would be 41/64 or 0.6406 inch, which, it will be seen, is 0.0094 inch less than the size obtained by the formula method. This method is extremely simple and easily applied, and in a great many cases the sizes can be determined by a mental calculation. A. A. D.

* * *

VALUE OF TRADE-MARKS

BY EDWIN M. GILES[1]

Owing to a misconception of the functions of a trade-mark, many persons for a long time thought that a trade-mark was only an excuse for charging an exorbitant price. Yet the trade-mark law was created solely for the protection of the buyer; it guarantees to the individual buyer that he will receive the commodity he desires.

The trade-mark was a most powerful factor in overturning the once basic principle of barter and sale: "Let the buyer beware." It was once the accepted practice, as it still is in the Orient and many other parts of the world, to cheat the buyer if possible. When a person buys a so-called "staple" article, he must either analyze and test each purchase to ascertain its purity, or he must take the word of the seller for this. Frequently the seller is a middle-man and must take the word of the manufacturer. The purpose of a trade-mark is to save the purchaser the expense and effort of testing goods. A trade-mark is the manufacturer's guarantee of the purity of any article bearing that mark. Because of their advertised value, the owners of trade-marks dare not, from selfish interests, permit the trade-mark to be applied to goods of questionable character. As a result, the largest concerns are trending toward the purchase of trade-marked material exclusively. Their buyers select two or more brands, which they have found most suitable, of each material used and then obtain prices for these. The medical profession for many years held that to specify or prescribe a trade-marked article was unprofessional and savored of quackery. Today almost all physicians specify trade-marked pharmaceutical preparations. They do so in order to be certain that the patient obtains something with which the physician is familiar. In this way the physician guarantees both to himself and to his patient the purity of his prescriptions.

Manufacturers are rapidly learning that it is of little concern to them how much profit is included in the price of goods they purchase as long as they can purchase these goods as low as any competitor and providing the quality is the best for their purpose. This attitude of the big buyers has acted as an encouragement and an inspiration to the producers of trade-marked articles. For there is no incentive like profit. As a result, the manufacturer using these articles finds his cost of operation being constantly reduced, not so much by the lowering of the first cost of materials as by the improvement in their quality and economy of use.

[1] Address: Care of E. F. Houghton & Co., Philadelphia, Pa.

DIAMOND TOOTH FORM FOR ROLLER CHAIN SPROCKETS[1,2]

It is a fact patent to all who have had experience with chains and sprockets that the particular form of sprocket tooth so long in use has been found decidedly unsatisfactory, and has not met the reasonable requirements of high-grade steel roller chains as made today for the transmission of power. In many cases chain drives have been abandoned and other means of transmission substituted, because of noise or rapid wear, due solely to poorly designed sprocket teeth. Some two years ago

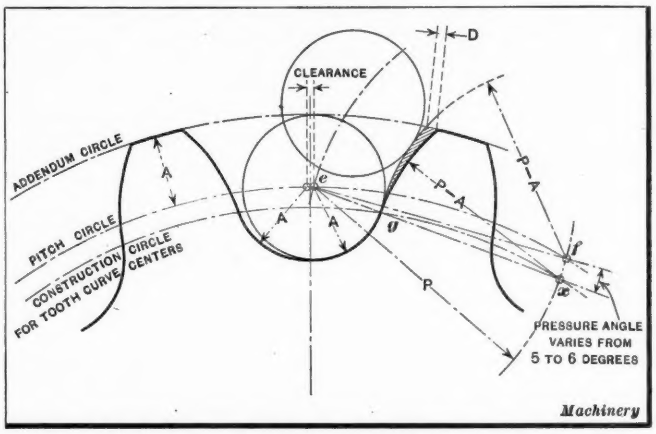


Fig. 1. Old Form of Sprocket Tooth with Pitch Line Clearance and Small Pressure Angle

it seemed to the Diamond Chain & Mfg. Co., Indianapolis, Ind., and a few others, that the time had come to apply scientific methods to the study of sprocket teeth, and to develop a tooth form that would be less noisy and more efficient than the old form. Accordingly its engineering department began a course of study and experimentation which has led to the development of the form herein described. Tests have extended over a period of nearly two years, and this firm is now regularly supplying sprockets and cutters of this design to its customers.

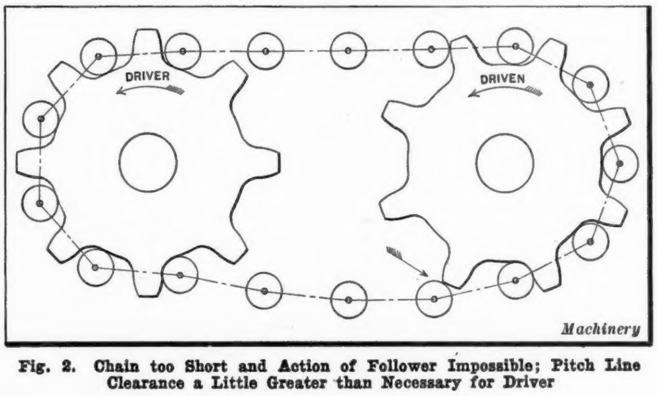


Fig. 2. Chain too Short and Action of Follower Impossible; Pitch Line Clearance a Little Greater than Necessary for Driver

Every chain begins to elongate as soon as it is put into operation, and this elongation, due to wearing of the rivets and bushings, continues as long as the chain is in use. To provide for this continual lengthening of the pitch, the old-style sprocket is cut with the clearance on the pitch line, thus allowing the rollers of an elongated chain to creep around the pitch circle without interference with the backs of the teeth. The Diamond chain sprocket tooth has only a slight amount of pitch line clearance, but the pressure angle is increased, so that as the chain elongates the rollers ride at higher points on the teeth, thus allowing the chain to adapt itself to its own proper pitch circle. A study of Figs. 1 to 6, inclusive, will make this perfectly clear. Clearance D at the end of the tooth was thought to be of chief importance, center x being so chosen that this clearance is always one-tenth of the roller diameter; and the radius of the tooth curve is equal to pitch P minus one-half the roller diameter, A. The last point of contact between the roller and tooth is at g, and the pull of the chain is in the direction ex. Hence the pressure angle is the angle included between ef and ex. This angle is about 5 degrees on a nine-toothed sprocket, and 6 degrees on a thirty-five-toothed sprocket. The pitch line clearance is usually about one-twentieth of the roller diameter; and when the pressure angle is only 5 or 6 degrees, this clearance is provided in order to allow space for the inactive rollers of a worn and elongated chain. After the chain has begun to wear, only one tooth will be in action at a time; and if this clearance were not provided, an elongated chain would tend to climb the teeth; but the small pressure angle would prevent this. See Figs. 2, 3 and 4.

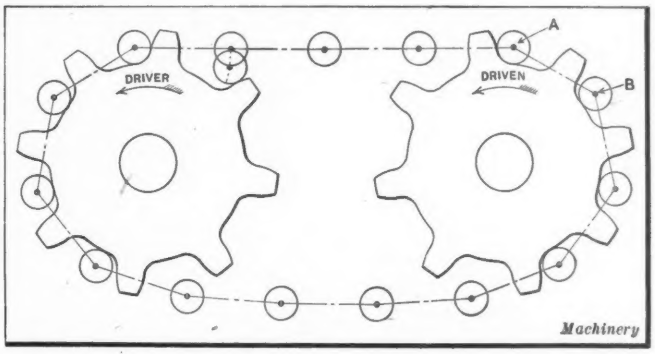


Fig. 4. Chain Elongated and Clearance Ample; when Roller A is released B will come against Tooth with Snap, making Motion of Sprocket Jerky

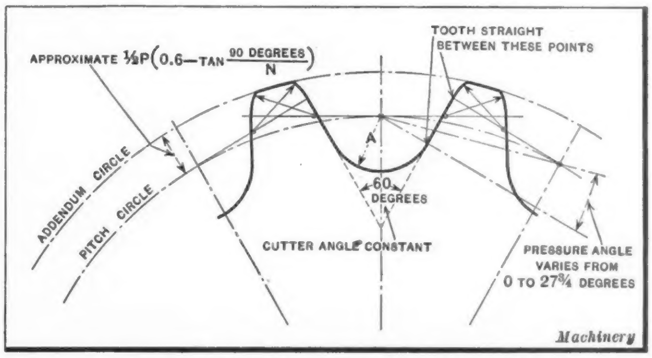


Fig. 5. Renold Form of Sprocket Tooth, with Uniform Space Angle of 60 Degrees, Variable Pressure Angle from 0 to 27¾ Degrees, and No Pitch Line Clearance

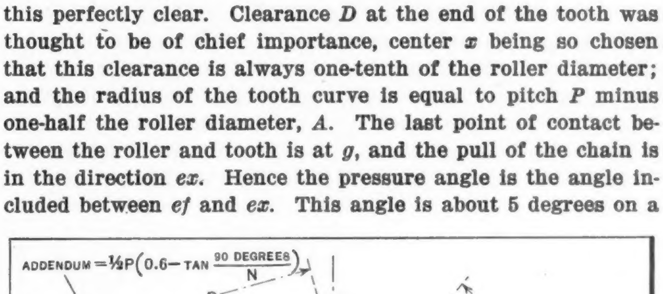


Fig. 6. Diamond Chain Sprocket Tooth Form, with Uniform Pressure Angle, Variable Space Angle, and No Pitch Line Clearance

In Fig. 5 is shown the tooth form used by Hans Renold, of Manchester, England, which has the merit of requiring only

[1] Abstract of booklet entitled "Diamond Tooth Form for Roller Chain Sprockets," published by the Diamond Chain & Mfg. Co., Indianapolis, Ind.
[2] For additional information on the design of sprocket teeth and allied subjects published in MACHINERY, see also "Design and Construction of Sprockets," by B. D. Pinkney, January, 1916, and other articles to which reference was made at that time.

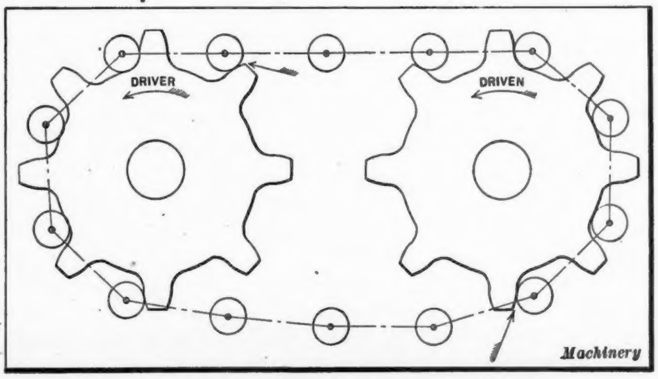
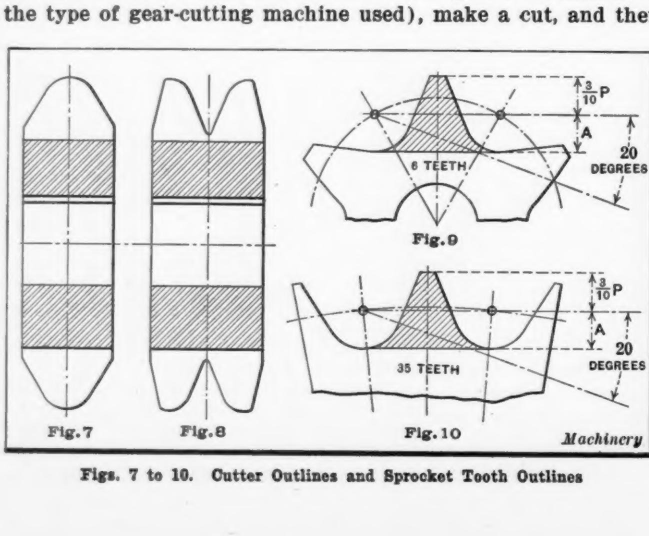


Fig. 3. Chain too Long and Clearance Insufficient

five cutters for cutting six to eighty teeth, of providing a shorter tooth and a greater pressure angle, allowing an elongated chain to adapt itself to a larger pitch circle by running on a higher portion of the tooth. A reduction of noise and of wear is also conspicuous, and the load is divided among all the teeth in mesh, instead of falling entirely upon one tooth. The pressure angles vary as follows: for six teeth, 0 degrees; for seven teeth, $4\frac{1}{4}$ degrees; for eight teeth, $7\frac{1}{2}$ degrees; for ten teeth, 12 degrees; for sixteen teeth, $18\frac{3}{4}$ degrees; for twenty teeth, 21 degrees; for eighty teeth, $27\frac{3}{4}$ degrees.

Fig. 6 illustrates the system developed by the engineering department of the Diamond Chain & Mfg. Co., which is said to have all the advantages of the Renold system, besides the following: Instead of making the angle of the tooth gap equal to 60 degrees for all sprockets, the pressure angle (or the angle formed by the line of action of the chain and a normal to the tooth outline at the point of contact) is kept constant and equal to about 20 degrees, thus following the well established principle used in connection with involute gear teeth. Sprockets with a greater number of teeth can be used, since we do not depend upon pitch line clearance to take up chain elongation, but upon the ease with which the chain adapts itself to a larger pitch circle. See Fig. 6. If cutters are used as shown in Fig. 7, five cutters will be required for cutting all numbers of teeth from seven to infinity. The range of pressure angles for any one cutter is $17\frac{1}{2}$ to $22\frac{1}{4}$ degrees. In ordering cutters of this type, give pitch, roller diameter and range of teeth to be cut. Cutters are made for the following ranges: seven to eight teeth, nine to eleven teeth, twelve to twenty-seven teeth, eighteen to thirty-four teeth, thirty-five teeth and over. If cutters are used like that shown in Fig. 8, only one will be required for cutting any number of teeth for a given pitch and diameter of roller. This means that a complete stock of cutters for the various sizes of chains made in this country from $\frac{1}{2}$ inch to 2 inches pitch would not exceed twelve in number. The pressure angle will be the same for every sprocket. This type of cutter cannot be used to cut teeth of the Renold type, since the contour changes for every change in the number of teeth to be cut.

An examination of Figs. 9 and 10 will show clearly the equality of tooth outlines in the Diamond type, and will explain why this great economy in cutter equipment can be effected. This type of cutter is known as the "Diamond universal sprocket cutter." In ordering, it is only necessary to specify the pitch and roller diameter, other dimensions, such as thickness, outside diameter, hole and keyway being standard. When this type of cutter is used it is recommended that the machine be indexed so that every other tooth will be cut first and the intermediate teeth afterward. This eliminates the tendency to produce a side thrust on the sprocket and thus spoil the accuracy of the indexing. To do this, use index gears for cutting half the given number of teeth. If the number of teeth is odd, either double the stop pawl number, if any, or double the number of teeth on one of the driving gears. Then when the blank has indexed through two revolutions, all of the teeth will be cut. If the number of the teeth to be cut is even, first cut half the teeth, then turn the blank through the space of one tooth (the manner of doing this depends upon the type of gear-cutting machine used), make a cut, and then



Figs. 7 to 10. Cutter Outlines and Sprocket Tooth Outlines

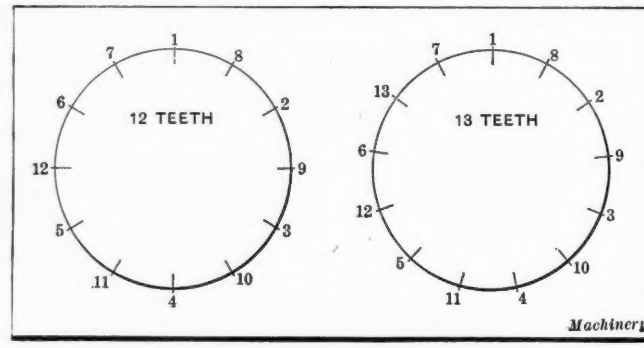


Fig. 11. Diagrams showing Methods of indexing for Even and Odd Numbers of Teeth

again index for every other tooth and cut the intermediate teeth. Fig. 11 shows the order in which the teeth are cut for a twelve- and thirteen-tooth sprocket, respectively.

Briefly, the essential differences between the Renold tooth form and that developed by the Diamond Chain & Mfg. Co. is that the former provides for a constant space angle and variable pressure angle, while the latter provides for a constant pressure angle and variable space angle.

To sum up, the Diamond chain sprocket tooth form has the following advantages over the form still largely in use: (1) The chain passes both on and off the sprocket teeth with greater ease; hence, less noise, less wear, and greater efficiency. (2) The pressure is distributed among all the teeth in mesh. (3) As the chain elongates, it adapts itself to a proportionately larger pitch circle, putting wear on a new part of the tooth, and thus reducing the tendency to "hook" the teeth. (4) The pressure angle is large. (5) The pressure angle is the same for all numbers of teeth. (6) An elongated chain will run as well on a sprocket with one hundred teeth as with twenty teeth. (7) Any number of teeth for a given pitch and roll diameter can be cut with a single cutter. (8) The length of tooth is so determined that the angular motion of the link between the pitch circle and the addendum circle is always the same (31 degrees).

The outside diameters for these sprockets are less than those usually tabulated. Instead of adding the roll diameter to the pitch diameter to obtain the outside diameter, the following formula is used:

$$\text{Outside diameter} = \text{pitch diameter} + P\left(0.6 - \tan\frac{90\text{ degrees}}{N}\right)$$

The rule for calculating the outside diameter may be stated thus: Divide 90 degrees by the number of teeth and find the natural tangent of this angle. Subtract it from 0.6000 and multiply the difference by the pitch. Add the result to the pitch diameter.

* * *

USES FOR SHELBY TUBING

New uses for Shelby steel tubing are constantly being found. A 16-inch lathe was one of the two tools in the repair shop in a Pennsylvania lumber mill, and a lathe with a hollow spindle was badly needed. So the superintendent got a length of Shelby steel tubing and sent it to the nearest shop to be made up into a hollow spindle. This worked out very nicely and was as good as the spindles made of ordinary machinery steel which are frequently put in on a repair job where the work is not heavy.

Another use for tubing is found in milling-machine collars. It requires no turning at all, for the various sizes of holes to suit standard arbors are "stock," and practically any outside diameter can be obtained. Dealers should select tubes which have the holes a trifle small; it is then only necessary to saw off the lengths, run a reamer through them, and face the ends. In spite of the higher cost of tubing over cast iron, such collars can be economically made and are to be preferred—except where collars are made as a slack time "filler" or for the experience of apprentices. D. A. H.

* * *

Although both discovery and invention refer to new things, discovery consists in finding new truths in nature, while invention is the applying of these truths to some desired purpose.

TUNGSTEN LAMP MANUFACTURE

PROCESSES USED BY THE UNITED INCANDESCENT LAMP CO., BUDAPEST, HUNGARY

BY CHARLES EISLER [1]

THE processes used in the manufacture of tungsten lamps are of considerable interest. Owing to the fragility of the various materials used in the construction, the machines and fixtures must be so arranged that they will perform their functions in a minimum time and with little likelihood of breaking the parts. Practically every part of an incandescent lamp requires the most delicate handling, from the tungsten filament to the glass bulbs. The processes and machines described in this article are based upon the practice developed by the United Incandescent Lamp Co., Budapest, Hungary, and while this is not secret, the writer believes that this material has never been published in detail form in this country. The various steps which are taken in connection with the manufacture of the lamp from the swaging of the tungsten billet to the final testing of the finished lamp will be described in this article and the machines used will be illustrated.

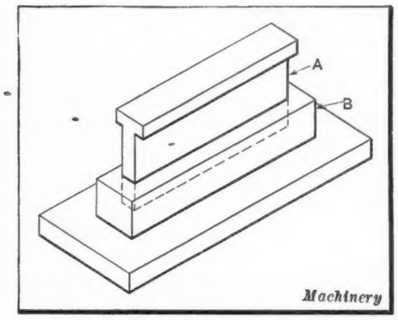


Fig. 1. Mold used for compressing the Tungsten Powder into Slug Form

Manufacturing the Tungsten Filament from the Slug

The powdered tungsten is first weighed and then poured evenly into a mold or die like that shown in Fig. 1, after which the mold is placed under a hydraulic press and compressed at a pressure of about 5000 kilograms per square centimeter. The die is made from high-grade tool steel, hardened and ground very accurately. The mold is usually made from 1/4 to 3/8 inch square and about 5 to 8 inches long. The depth of the die is considerably more than the slug is to be, in order to give the plunger *A* a good location in the die before the tungsten is compressed. After the bars have been compressed they are fragile and their handling requires skill. A hydrogen furnace is used to unite these bars, the temperature being about 2000 degrees C.

Heating and Swaging the Slug

A special electric furnace such as that shown in Fig. 3 is used to heat the slug to a temperature of from 1200 to 1300 degrees C. in an atmosphere of hydrogen. Referring to Fig. 2, the various parts of the tungsten lamp will be seen, and the form produced on the tungsten slug by the first swaging operation can be noted at *A*. One end of the slug is formed for a distance of 80 or 90 per cent of the length, after which it is

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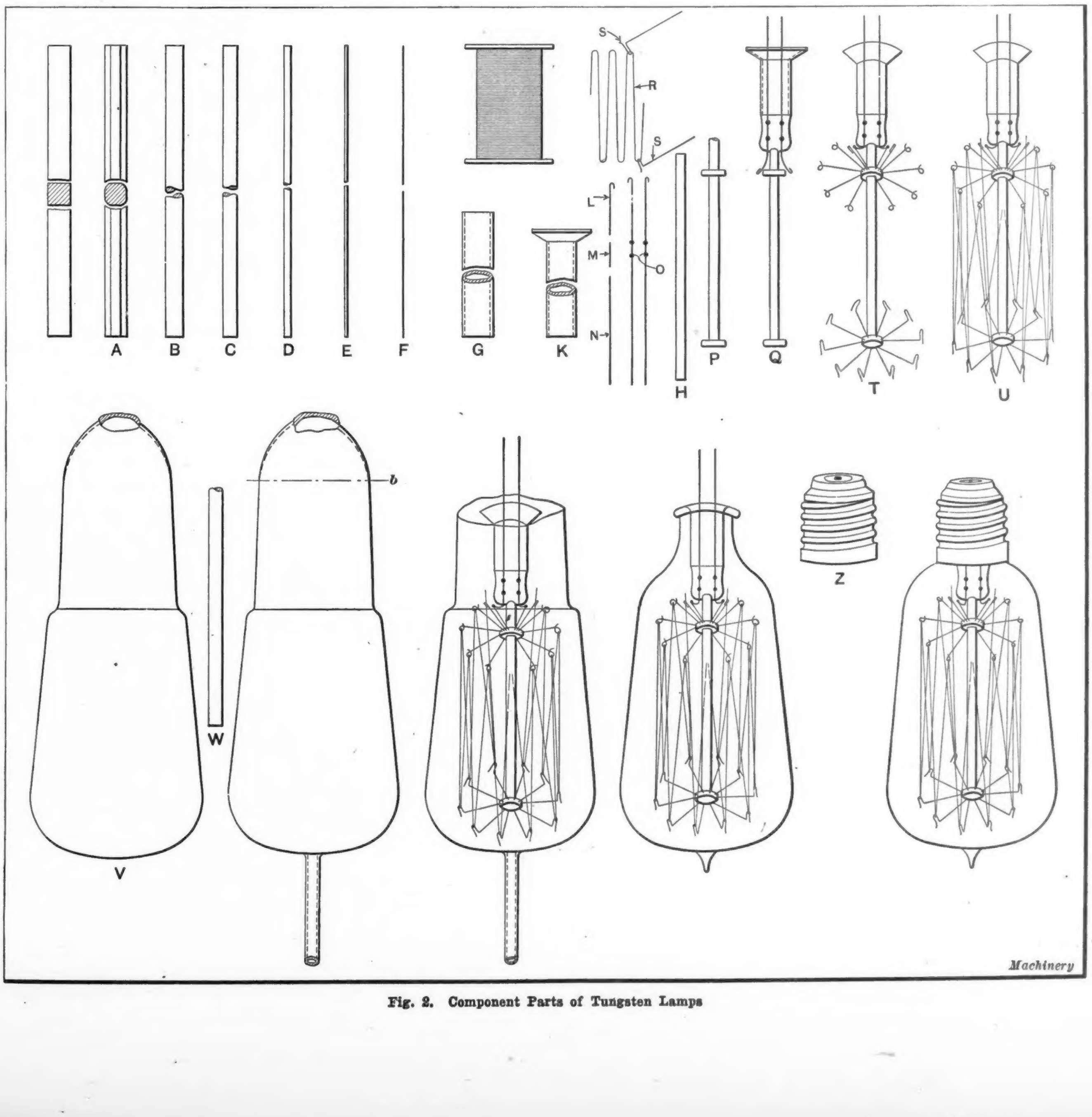

Fig. 2. Component Parts of Tungsten Lamps

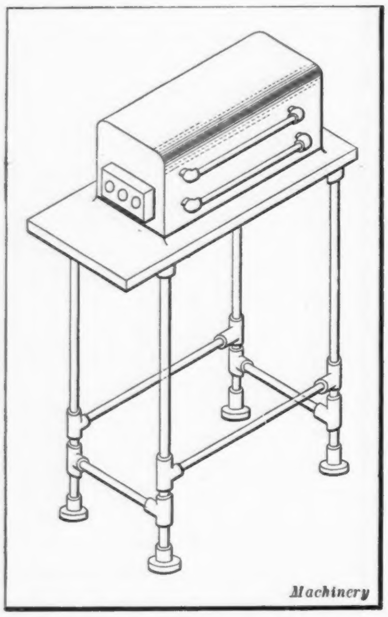

Fig. 3. Electric Furnace used for Slug Heating

reheated and the other end swaged to completion. The handling of the slug from the furnace to the swaging machine is done very rapidly in order to prevent the slug from oxidizing as far as possible.

Hot-swaging the Slug

After the slug has been heated to the proper temperature, it is removed by means of the pliers shown in Fig. 5 and transferred to the swaging machine for the first operation, which consists of forming it into octagonal shape. Fig. 4 shows a hot swaging machine built by the Langelier Mfg. Co., Providence, R. I. These machines are built in several sizes, the same principles being incorporated in the various machines, with the exception that in the case of the No. 1½ hot swager, there is an annular recess or chamber inside the machine head, through which a stream of cooling water is kept running in order to prevent the machine from heating unduly during the handling

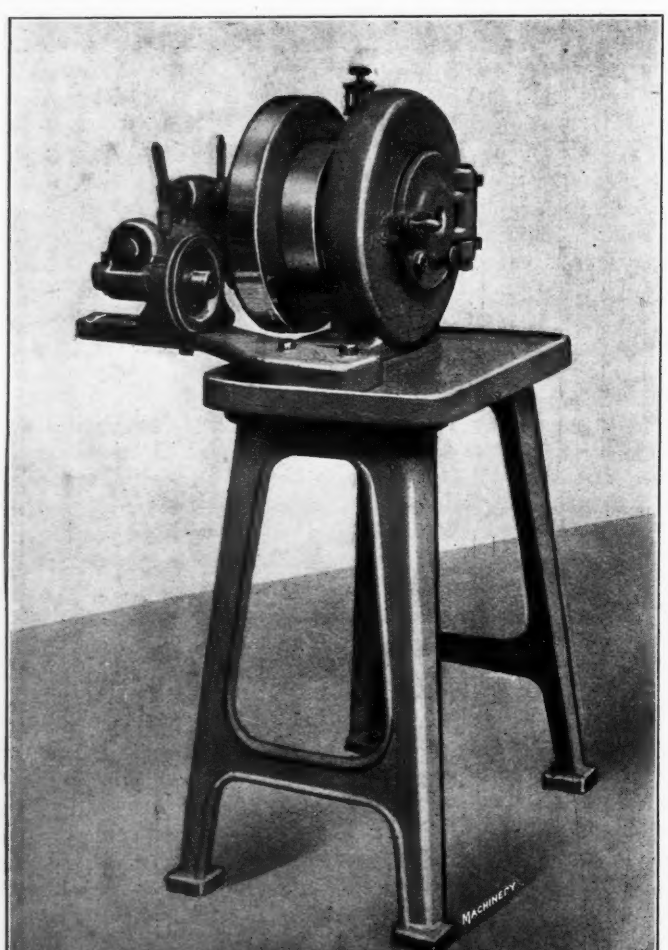

Fig. 4. Langelier Swaging Machine

of the hot tungsten wire. The sectional view shown in Fig. 6 is taken directly through the center of the spindle and shows the construction very clearly. The spindle is slotted across the enlarged end to receive a pair of hammer-blocks and dies *A* and *B*, the reciprocating action of which is in a radial direction. The spindle is driven by the pulley *C*, which has a heavy

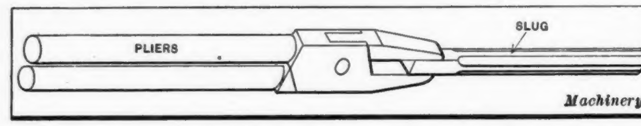

Fig. 5. Pliers for holding Tungsten Slug while swaging

rim and acts as a flywheel, producing a steadier movement. As the spindle revolves, the jaws are thrown outward by centrifugal force, so that the outer ends strike against the steel rolls *D*, which throw them back again toward the center. There are a number of these rolls on the inside of the cage so that the reciprocating action of the jaws is very rapid. This type of machine was described in detail in the January, 1914, number of MACHINERY on page 420.

Fig. 2 shows at *A*, *B*, *C*, *D*, *E* and *F* the various steps through which the tungsten slug passes in being swaged to the required size. The rods are swaged from 5/16 inch square to 1/32 inch round in steps of about 0.020 to 0.025 inch at a time. When the rod has been swaged to 1/32 inch, it is usually from

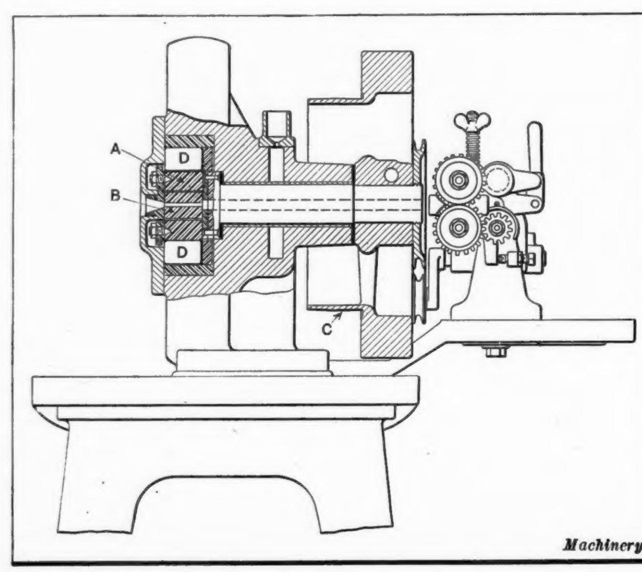

Fig. 6. Longitudinal Section through Head of Langelier Swaging Machine

75 to 100 feet long. From 1/32 inch, the wire is drawn at a cherry red through diamond dies by steps of 0.002 to 0.005 inch until it is about 0.003 inch outside diameter. For the smaller sizes it is drawn by steps of 0.001 inch down to 0.001 inch outside diameter, or even smaller if required. Wire has been drawn down to 0.0004 inch outside diameter and to lengths of from 10,000 to 11,000 feet.

Drawing Wire Through Diamond Dies

After the swaging operations have been performed, the wire is drawn through diamond dies as shown in Fig. 7. The drawing operations are performed on several sizes of machines.

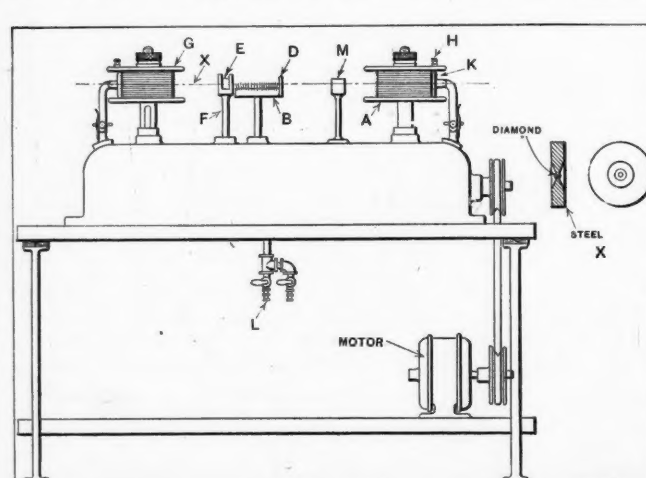

Fig. 7. Machine used for drawing Tungsten Wire through Diamond Dies

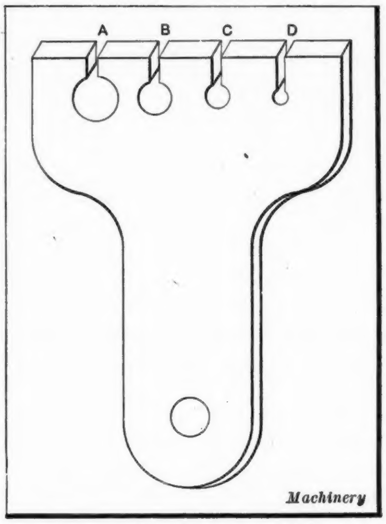

Fig. 8. Gage for Glass Tubing

according to the diameter of the wire. The wire is drawn at the rate of from 10 to 85 feet per minute, the speed depending on the size of the wire. The operation is as follows: The wire is placed on spool A and led through lubricator M and guide D over gas flame B and through die E. This die is held in a bracket F and the wire X is wound on the spool G. This spool travels vertically up and down a distance equal to the width of the spool, in order to distribute the wire evenly on it. The end of the wire is held on the spool by the screw H, and the protector K is provided to keep the wire on the spool in case it should break during the drawing operation. The wire is heated to a cherry red heat while being drawn, the gas and air mixers at L being provided for this purpose; these supply the gas for the burner B.

Cleaning and Flashing the Wire

The wire is now cleaned and annealed under hydrogen by the machine shown in Fig. 9. It is taken from a spool at

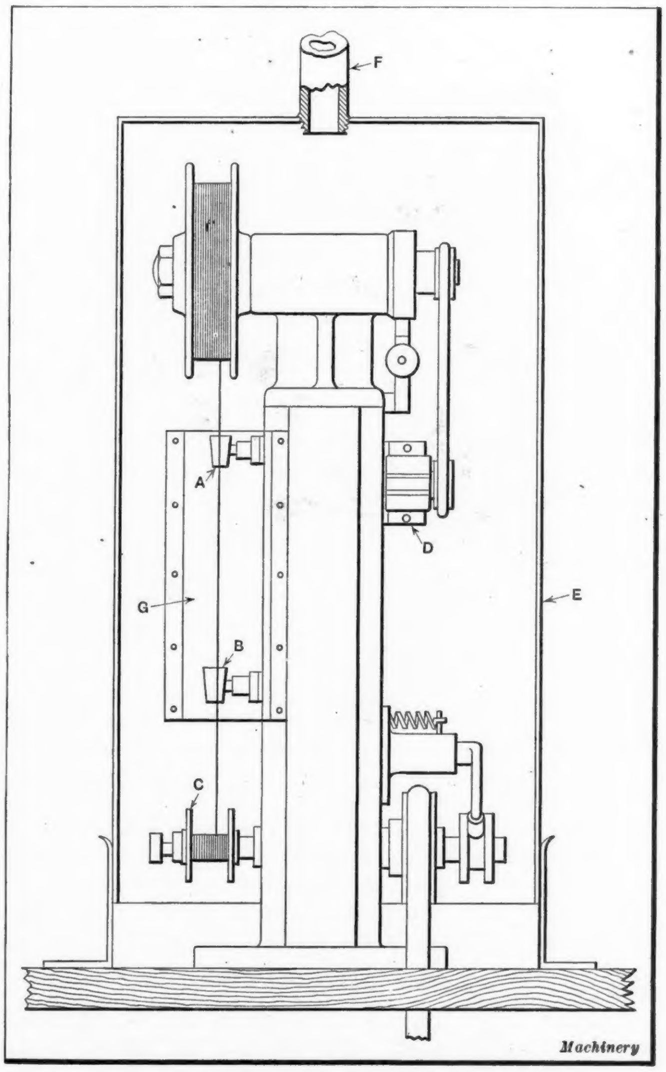

Fig. 9. Machine used for cleaning Tungsten Wire

the top, drawn through the mercury cups A and B onto the spool C, which is passed back and forth to allow the wire to be distributed evenly on its surface. A speed recorder D shows

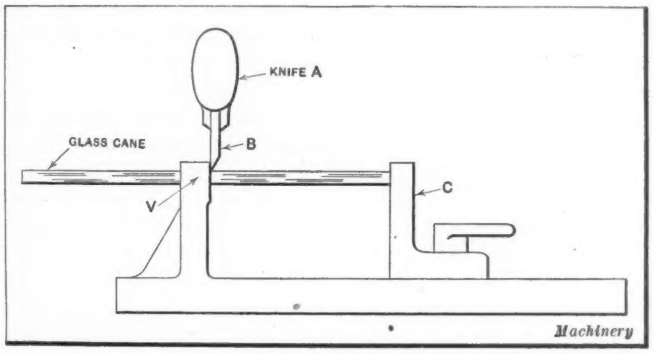

Fig. 10. Cutting Glass Tube on Hand Fixture

the number of meters which are run from each spool. The machine is covered by a hood E, which contains hydrogen gas and is provided with a mica window G so that the operator can observe the working of the wire.

The mercury cups A and B form the terminals through which an electric current passes which heats the wire in

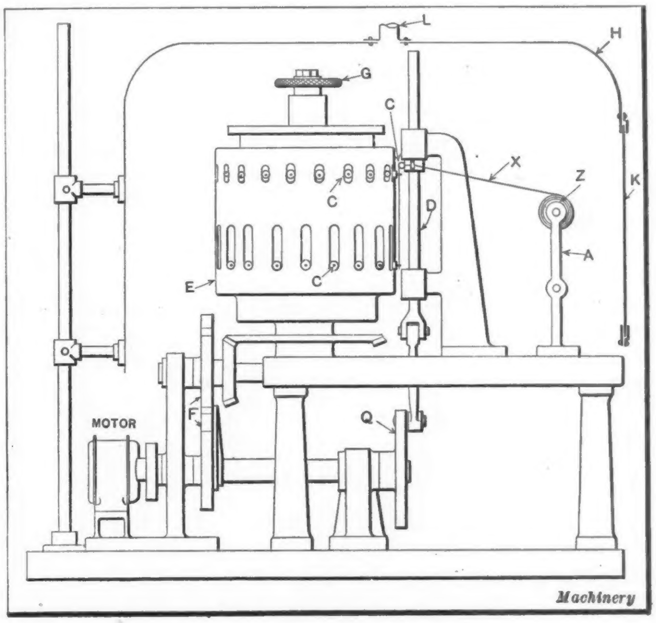

Fig. 11. Forming Zigzag Filament

transit, and while this is being done it must be run under hydrogen in order to keep it from becoming oxidized. This process of heating the wire electrically as it passes through the mercury cup is called flashing. The hydrogen is let into the hood by the inlet pipe F, and provision is made for raising and lowering the hood by means of a sprocket chain and hand-lever not shown.

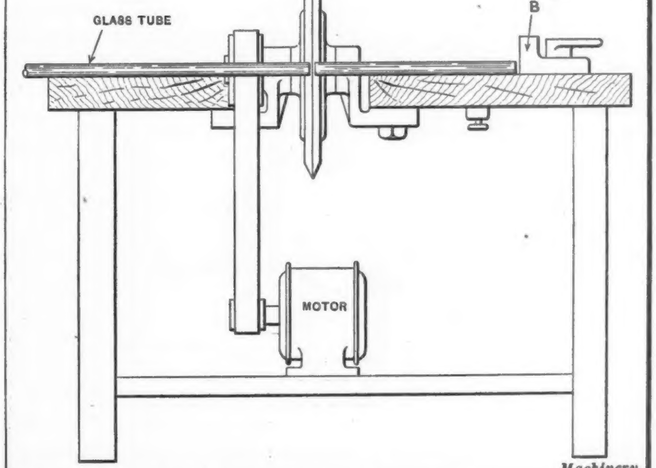

Fig. 12. Cutting Glass Tube with Emery Wheel

Forming the Zigzag Wire

A special forming machine shown in Fig. 11 is used to form the wire into zigzag shape after it has been cleaned as described in the previous operation. The process is as follows: The spool *Z* is filled with wire and placed on the bracket *A*. The wire *X* is bent over the pins *C*, which are adjustable for different lengths of the zigzag. The machine is driven by the electric motor shown through a stop motion of the Geneva type shown at *F*. The wire is drawn from the spool through a holder on the sliding rod *D* controlled by the eccentric shown at *Q*. Adjustment is obtained by turning the knurled nut *G*. The pins *C* are insulated to give the proper electrical contact, as the shape of the wire is formed while it is red hot. The mechanism is covered by a sheet metal hood *H* having a mica opening at *K* to permit the operator to see the work. The operation is performed under hydrogen as in the preceding case, the gas entering the hood at *L*. The tungsten wire is

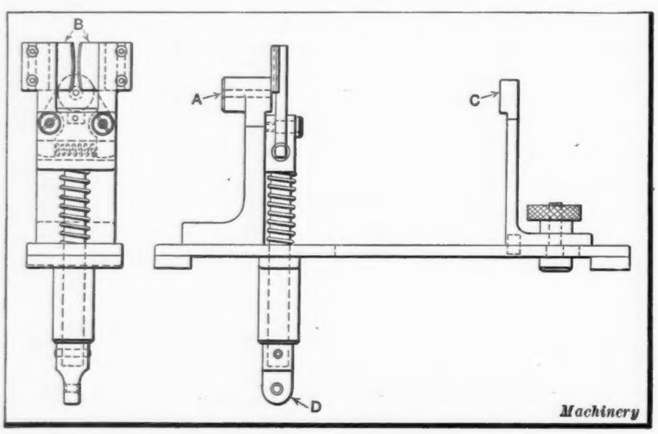

Fig. 13. Machine Fixture for cutting Glass Tube

shaped under the hydrogen hood in order to prevent the filament from oxidizing. The hood can be raised by means of a chain and handwheel.

Cutting the Glass Tube

Several methods of cutting the glass tubes are in vogue, but the operation of cutting is very simple. The tube shown at *G* in Fig. 2 is cut on an ordinary rotating wheel as shown in Fig. 12. A V-shaped carborundum wheel *A* is used and the tube held against the stop *B*, which is adjustable for various lengths. The operator can handle more than one length of glass when cutting by placing one on top of the other. It must not be understood that the glass is entirely cut through by the wheel, as it is simply nicked a little and then cracks off, due to the heating action of the wheel on the glass. The tubes are cut from lengths of about three or four feet, and with this method 2500 to 3000 can be cut per hour. The glass cane shown at *H*, Fig. 2, can also be cut by this method, but another device is used for the solid glass rods.

Fig. 10 shows a hand fixture used in cutting the glass rod *H*, the cutting in this case being done by a knife. The most common type of knife in use is that shown at *A*, although others are being used to some extent. The knives are made of special tool steel and hardened. When regrinding, they must be ground on stones under a stream of water, in order

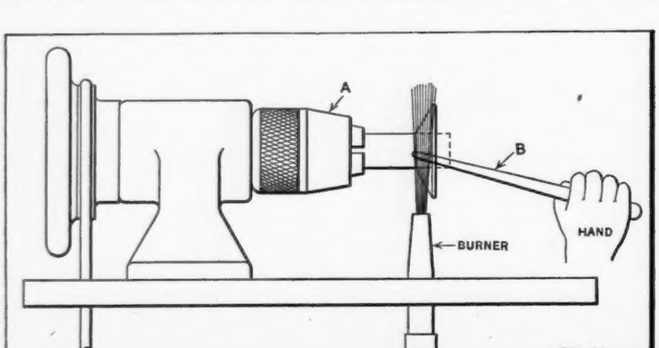

Fig. 14. Flanging Glass Tube to make the Flare

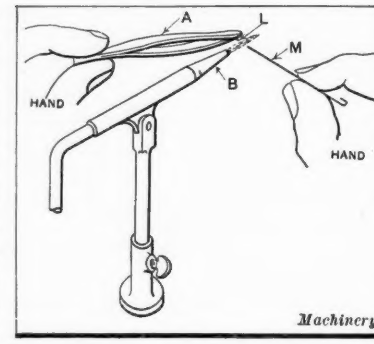

Fig. 15. Welding Tungsten and Platinum Wires

to guard against the temper being drawn in the slightest degree.

The knives shown at *B* in Fig. 13 are used in a fixture in which the glass rod is fed through the hole *A* and is held against the adjustable stop *C*. The knife blades are then pulled down by the plunger *D* by means of a foot-treadle not shown in the illustration. By this method the glass is scratched on both sides and then cracked off. From 2000 to 2500 pieces per hour can be produced in this way by a girl. In sorting, a regular snap gage is used such as that shown in Fig. 8. This work is done before the tubes or canes are cut to the required length. About eight or ten rods or tubes can be held in the operator's hand at one time and gaged very rapidly. At *A*, *B*, *C* and *D* are shown the slots for the different sizes.

Making the Flange

The glass tube *G*, Fig. 2, is heated in a special rotary chuck *A* shown in Fig. 14, and when the glass has been heated to the proper temperature it is flanged by the rod *B* to the shape *K*,

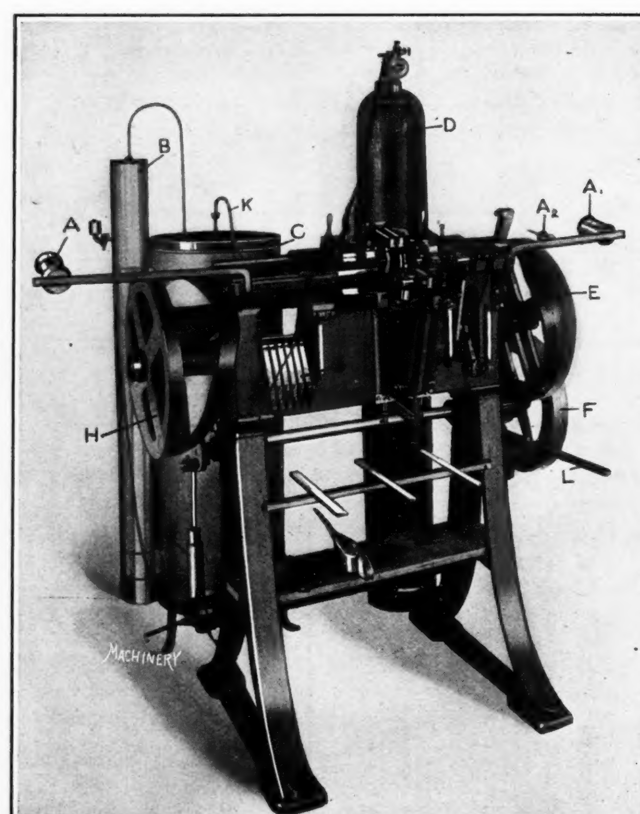

Fig. 16. Automatic Machine for welding Lead-in Wires

Fig. 2. In the majority of cases two or more rotary chucks are used so the maximum production will be obtained. When two chucks are used, one is being heated while the other is being loaded. The forming is generally done by hand, but may be done automatically if desired.

Making the Lead-in Wire

Referring to Fig. 2, *L* is a nickel lead-in wire of which one end is bent and clamped to the filament and welded to *M*, which is made from platinum or a substitute. This portion is usually 1/8 inch long and has a diameter of 1/64 inch approximately, depending upon the size of the lamp. Platinum is used because it has the same coefficient of expansion as the glass. *N* is a copper wire, the ends of which are soldered to

the base after the lamp is based. The wires L, M and N are electrically welded together as shown at O, and two are used in each lamp. It is an interesting fact that the majority of lamps of this kind contain platinum, and up to the present time it has been difficult to procure any substitute.

In making the welds on pieces L and M, the part L is held with a pair of tweezers A, as indicated in Fig. 15, while the part M is held by hand, and both ends are brought together over the needle gas burner B and welded. This operation looks difficult, but an operator with little experience can get a production of approximately 350 pieces per hour. The part N is handled in the same manner.

Fig. 16 shows a machine which is a standard product of a German manufacturer for welding lead-in wires. This machine is arranged to take three different kinds of wires and

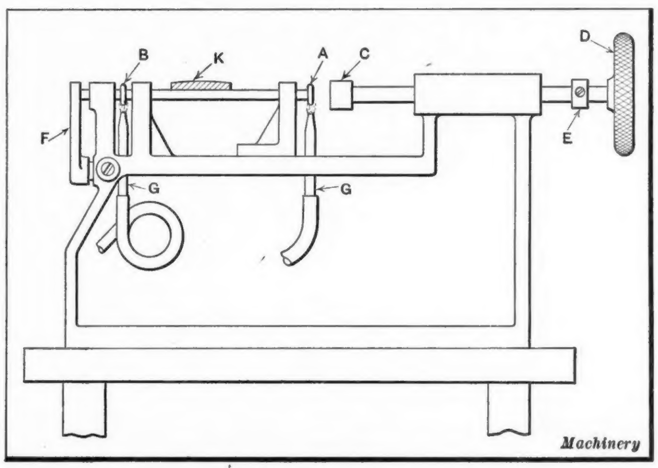

Fig. 17. Fixture for making Cane Rod Buttons

weld them into one complete unit, the production being in the vicinity of 2500 pieces per hour. It can be arranged to make hooks or tubes as desired. Referring to the illustration, A, A_1 and A_2 are, respectively, the copper wire roll, the nickel wire roll, and the platinum wire roll. The gas regulator and the gas tank are shown, respectively, at B and C, while the hydrogen bottle can be noted at D. The driving pulley and flywheel are shown at F, and the gear and cam by means of which the slides are operated are indicated at E. The gas compressor G is driven from the main shaft. The electrical contacts are at I. The movement of the slide is controlled by the cam wheel H.

Making the Cane Rod Buttons

The glass arbor or cane rod shown at H in Fig. 2 is cut to length and sorted to the proper size, as previously described. After it has been cut, the rod is inserted in the fixture shown in Fig. 17, in order to make the buttons or enlarged ends as shown at P in Fig. 2. The glass rod is located in U-grooves and the flames G heat the part where the button is to be made. After sufficient heat has been applied, the end of the rod is pressed by hand by the knurled knob D and the anvil on the end of rod C. An adjusting collar is provided at E and another adjustment for the other end may be noted at F. While the rod is being heated, it is turned back and forth by a fiber turner K to form the button to the required shape. Other methods are used for doing this work, but the process shown produces good results and is inexpensive. Five or six arbors can be handled at one time, and the anvils can be arranged to be operated by a foot-lever if desired.

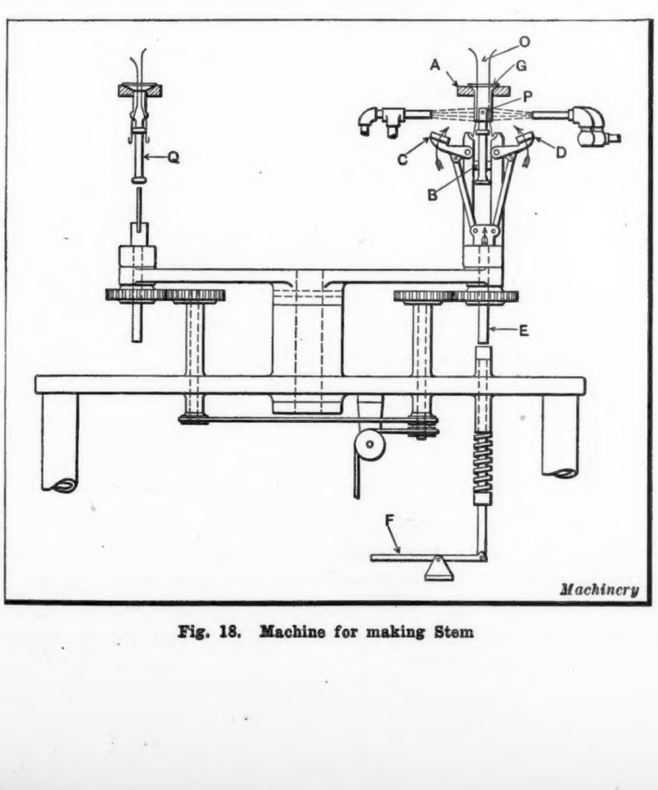

Fig. 18. Machine for making Stem

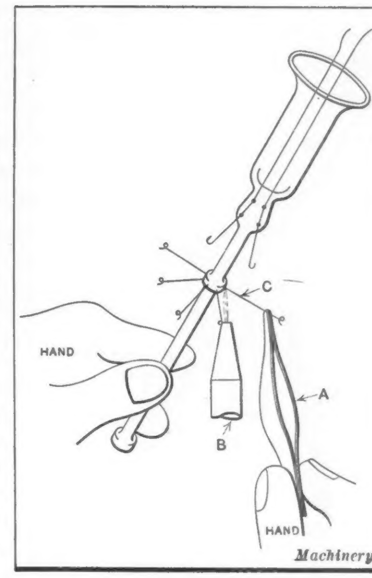

Fig. 19. Inserting Anchor

Stem Making

A complete stem consists of parts K, O and P, Fig. 2, which are assembled to make the piece Q. The flare, lead-in wires and arbor are inserted in a holder as shown in Fig. 18. The flare is held in a sort of nest and the arbor by the jaws shown at B. While the welding flames are softening the glass parts the head is rotated, and after the glass has been softened sufficiently the clamping is performed by the jaws C and D and the plunger E, actuated by the foot-lever F. Machines of this type frequently have from one to eight separate heads. After this operation has been performed, the stem is ready for the insertion of the filament supporting anchor.

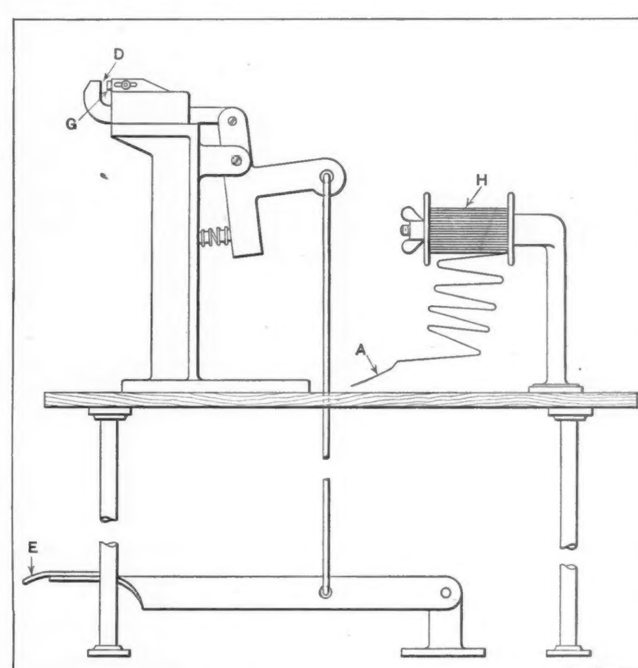

Fig. 20. Fixture for clamping Zigzag Filament to Lead-in Wires

Inserting the Anchor

The anchor is made of nickel wire and the end is coiled on a special machine at the rate of 5000 per hour, after which the wire is inserted in the stem as shown in Fig. 19. The flame from pipe B is directed against the button and anchor C while the nickel wires are set in place by tweezers A, a

needle burner being used for this work as previously described. A part of the hub and the short end of the anchor *C* are heated and inserted by hand, as indicated.

Mounting the Zigzag Filament

The zigzag filament shown at *R* in Fig. 2 is taken from a drum and mounted on hooks as shown at *S;* in addition, the two ends of the tungsten wire are clamped to the lead-in wires

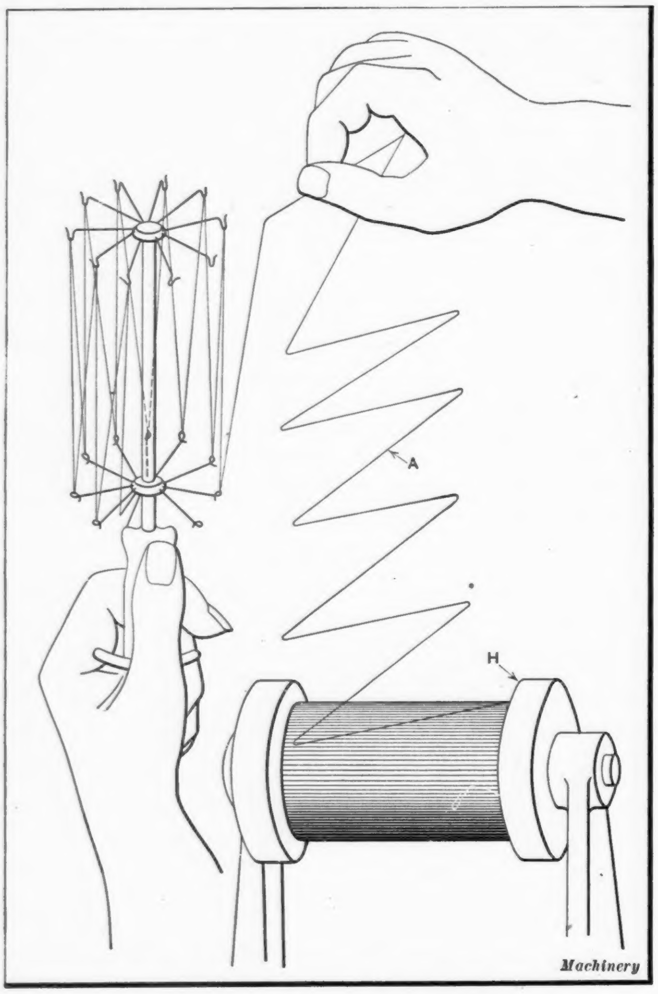

Fig. 21. Method of assembling Zigzag Filament

as shown at *U*. In this operation the zigzag wire is removed from the spool on which it has previously been wound, as indicated in Fig. 21, and hooked over the anchors by hand. After this has been done, the operator takes the end of the wire *A* and holds it in the hooked end of the lead-in wire while this is placed between the jaws *D*, Fig. 20. By pressing down on the lever *E* the jaws are moved together to clamp the wire in place. After one end has been clamped, the operator winds the zigzag on the hooks, clamps it and cuts off the end at the same time with a knife. During this operation the work is held at a slightly different angle. It will be noticed that the zigzag wire has already been wound on the spool *H* into the V-shape that it will have when mounted. This operation is done when the wire is taken off from the forming machine shown in a previous illustration. The spool *H* is conveniently accessible to the operator, so that the work can be done very rapidly. It will be understood that the work shown in Fig. 21 of pressing the zigzag filament on the anchors is done after one end of the wire has been clamped, as stated.

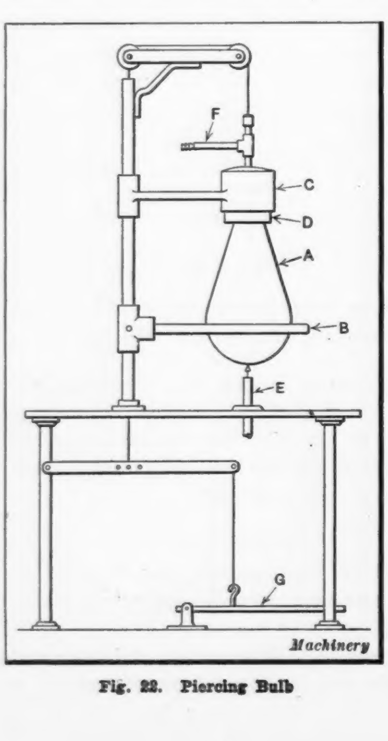

Fig. 22. Piercing Bulb

Operations on the Bulb

After the bulb shown at *V* in Fig. 2 comes from the glass molds, it is first washed. The piece shown at *W* is the so-called top tubing which has been cut and sorted to the proper size. This tubing is cut into three-foot lengths by the same process as was employed for cutting the glass canes.

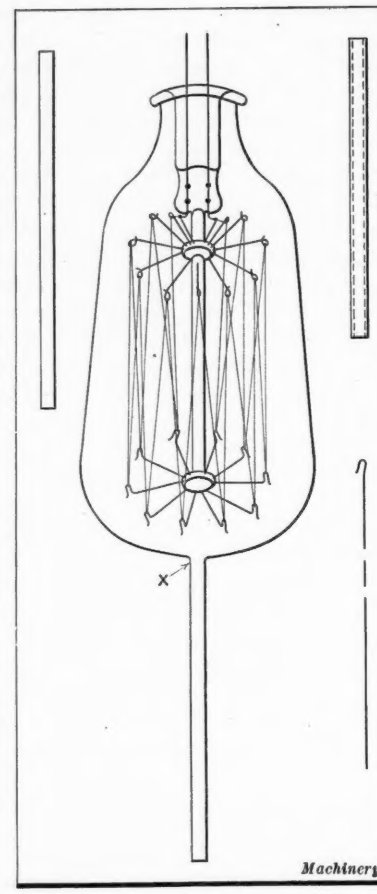

Fig. 23. Bulb with Tube and Stem assembled

Piercing the Bulb

Before the top tubing *W* is sealed on the bulb, it is necessary to pierce a hole as shown at *X* in Fig. 23. The method of piercing this hole is clearly shown in Fig. 22. The bulb *A* is placed in the nest *B;* the cap *C* is lowered, and the rubber ring *D* acts as a seal on the bulb. *F* is the air inlet to

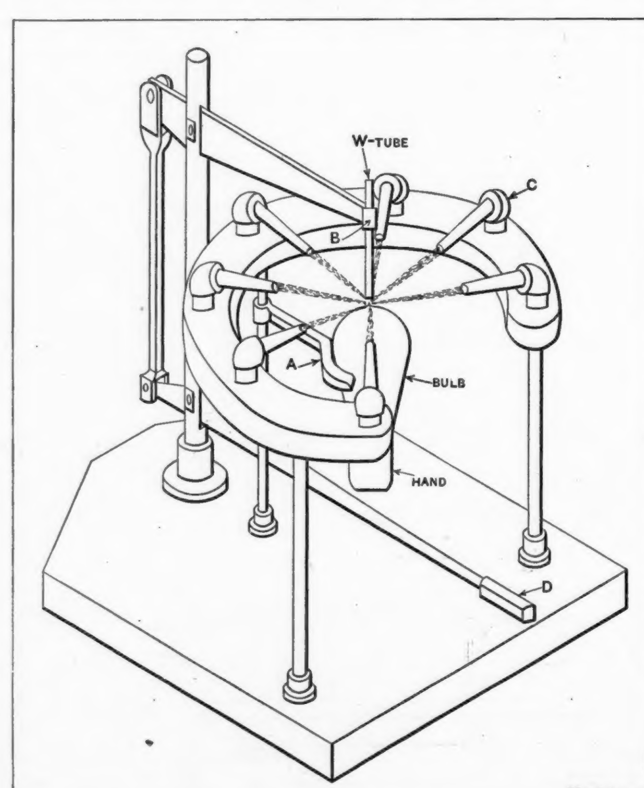

Fig. 24. Tubulating Bulb

which a rubber tube is connected when in operation. The air enters the bulb while the flame heats the part where the hole is to be pierced. As soon as the glass has become soft from the gas flame *E*, an opening is caused by the air pressure,

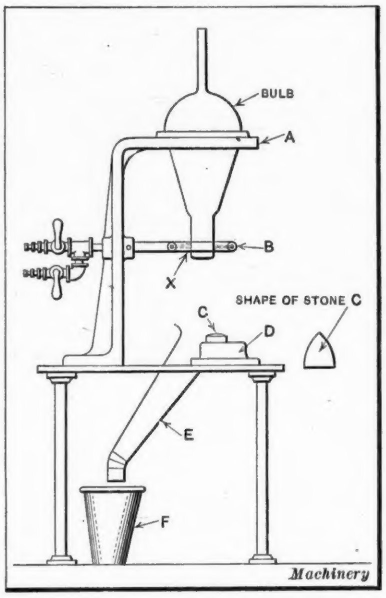

Fig. 25. Cracking off Collar

after which the cap C is raised by removing the pressure from the treadle G. The air pressure used is from 4 to 5 pounds per square inch.

Tubulating the Bulb

The tube is inserted in the bulb on a machine shown in Fig. 24. The bulb is held by hand in the nest or case A while the tube is held by a spring chuck B. The flames C must concentrate on the center of the bulb and on the end of the tube, and when both parts are heated to the melting point the tube W is pressed lightly against the bulb by the hand-lever D. This lever is connected with the burners C in such a way that as soon as the lever is touched the flames stop burning. During the course of the operation, the bulb is turned back and forth a little until it is sufficiently hot to make the seal.

Cracking Off the Collar

The apparatus used for cracking off the bulb collar is shown in Fig. 25. The bulb is placed in the fixture A and the part to be cracked off at X centers in a ring burner which heats the bulb all around. Then the bulb is removed and the end X is placed on a saturated stone such as that shown at C, or on any other substance which will hold moisture. As soon as the

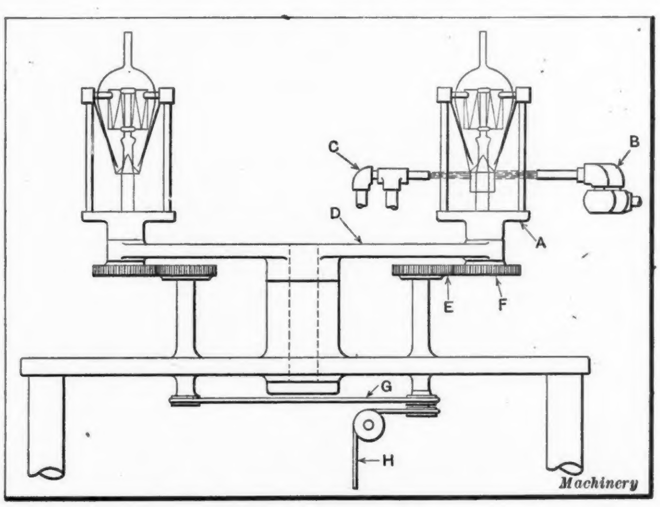

Fig. 26. Sealing Bulb

hot glass strikes the stone the collar breaks off, leaving a clean fracture. D is the water container intended to supply the moisture, E is a chute for scrap, and F is a scrap pail. In operating, the bulb is held on the stone C until it cracks off, the operator in the meantime having placed another bulb in the holder A, making the operation almost continuous. About twenty to twenty-five seconds is the time taken to perform this operation. The top tubing is used to locate the bulb during the operation of exhausting.

Sealing the Bulb

The bulb and stem are located in a rotating holder as shown at A in Fig. 26. While this is rotating, the two segmental fires (Bornkessel) B and C heat the bulb until both parts are melted together as shown. There are usually four or more arms or heads D, so that the bulb can be heated gradually and the finished bulb allowed to cool while one position is being finished. The holder or head A is rotated by the gears E and F driven by the belts G and H. The operator always remains in the same position in relation to the holder. When the work is completed, the operator simply turns the arm D by hand for the next position. Automatic attachments for indexing are also made for machines of this kind.

Exhausting the Lamp

The method of exhausting the lamps is shown in Fig. 27. The lamps B are inserted in the rubber tubes C, and the lead-in wires are wrapped around pins A through which an electric current passes. The tubes C are on a common manifold which is connected to the vacuum line D. After the lamps have been placed in their proper position, they are raised into the oven E which is kept hot by gas flames. The oven temperature is raised to as great a degree as the lamps will stand without damaging them, and they are left here for a short time, after

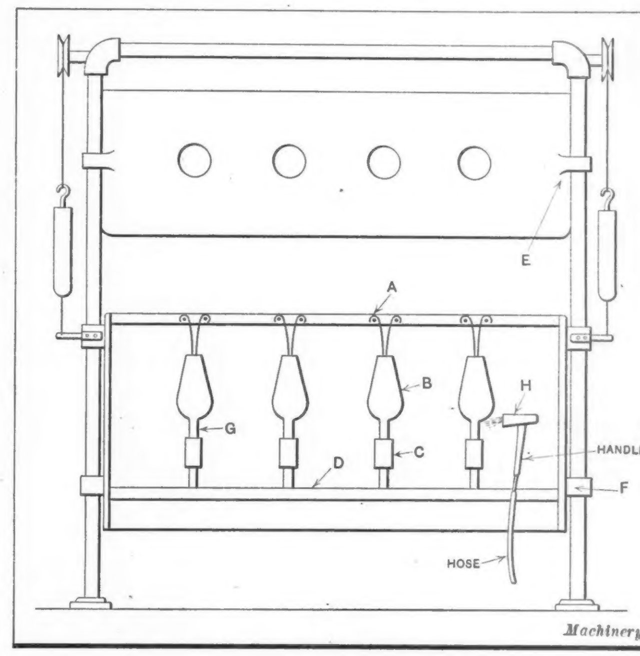

Fig. 27. Apparatus used for exhausting Lamp

which they are lowered again and burned at about 120 per cent rating for four or five minutes.

After this the lamps are tipped off, that is, the tube G is cut off with a hand torch as shown at H, and then removed for other operations. The vacuum obtained varies according to the size of the bulbs and the shape of the lamps. A high vacuum of 0.001 millimeter, mercury pressure, is obtained in some cases. In any event, the vacuum must be as perfect as is commercially possible.

Basing the Lamp

The bases shown in Fig. 2 at Z are filled with cement and placed on the bulbs, after which they are located in the basing fixture as shown in Fig. 28. There are two separate carriages

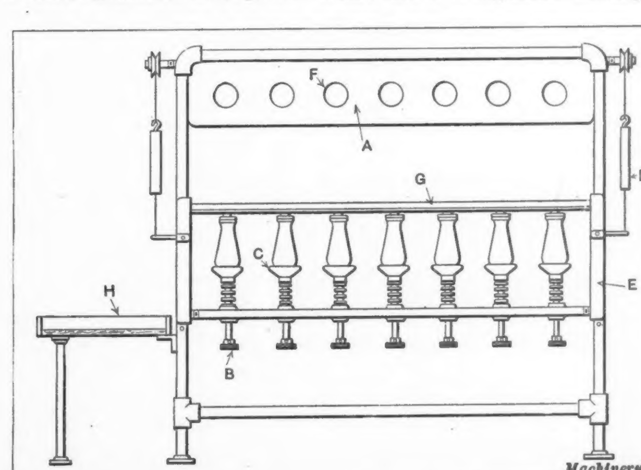

Fig. 28. Basing Lamp

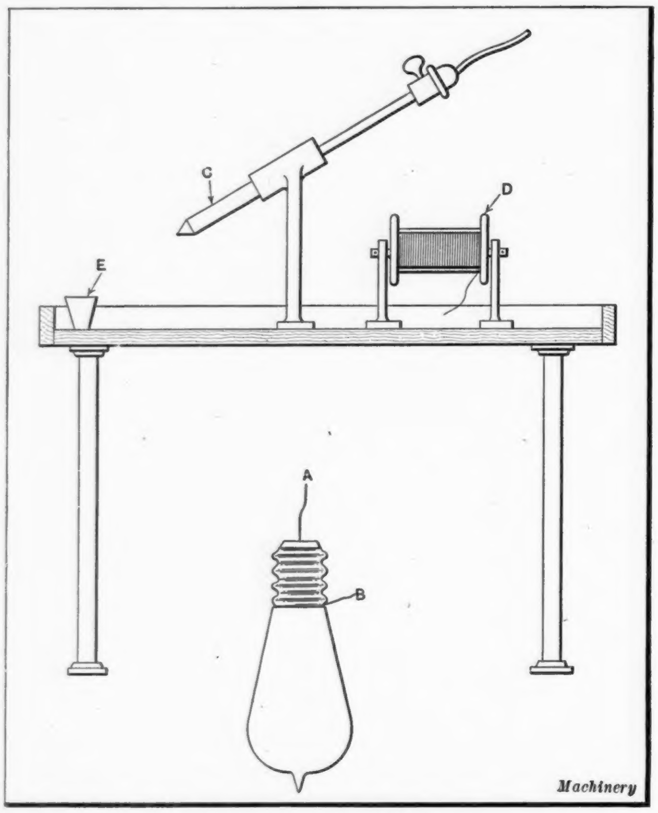

Fig. 29. Soldering Lead-in Wires

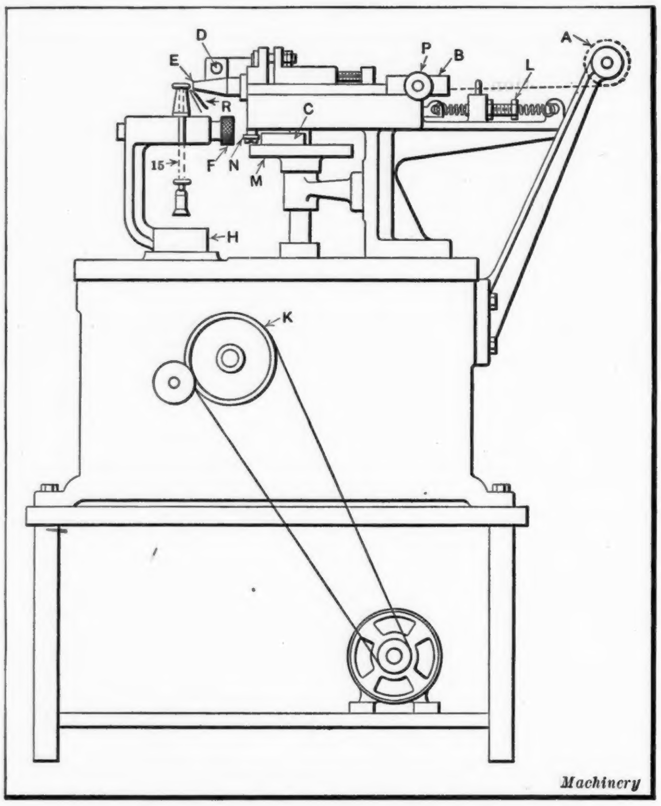

Fig. 30. Machine used for inserting Hook End of Nickel Wires

on which the bulbs are placed, only one of which is shown in the illustration, the other being in the gas oven shown above. It will be noticed that all the lamps are in a line, so that the operator can easily determine whether they are set up straight or not. In operation, the base and lamp are held by the plunger *B*, and the cone cup *C* is held in position by the coil spring shown. Weights are provided at *D* to balance the slide or carriage *E*. The oven is provided with holes *F* covered with mica so that the operator can see that the lamps are not being overheated. The portion *G* acts as a guide for the Edison bases, and *H* is the table on which the operator works while the lamp bases are backed on the lamps.

Soldering the Lead-in Wires

After the Edison sockets have been baked on the bulbs the lead-in wires project from the base as shown at *A* and *B* in Fig. 29. An electric soldering iron *C* is used for soldering these wires, the iron being stationary while the lamp is held in the correct position for both *A* and *B*. The solder is in wire form on a spool *D*, a soldering paste box being provided at *E*. After the soldering operation, the projecting wire is cut off by a special knife.

The socket is now polished on a regular polishing wheel in order to clean it perfectly, the polishing wheel being located very close to the soldering fixture.

Inserting the Hook End

The inserting of the hook end of the nickel wires is done by means of the special machine shown in Fig. 30. The wire is drawn from the spool *A* and straightened at *B*, being carried from the straightener by a slide. The forward movement of the slide is governed by the cam *C* and the roller *N*. On the return stroke, guide bushing *E* stops, and knife *D* cuts the wire, actuated by cam *M*. Bracket *H* rotates and stops at

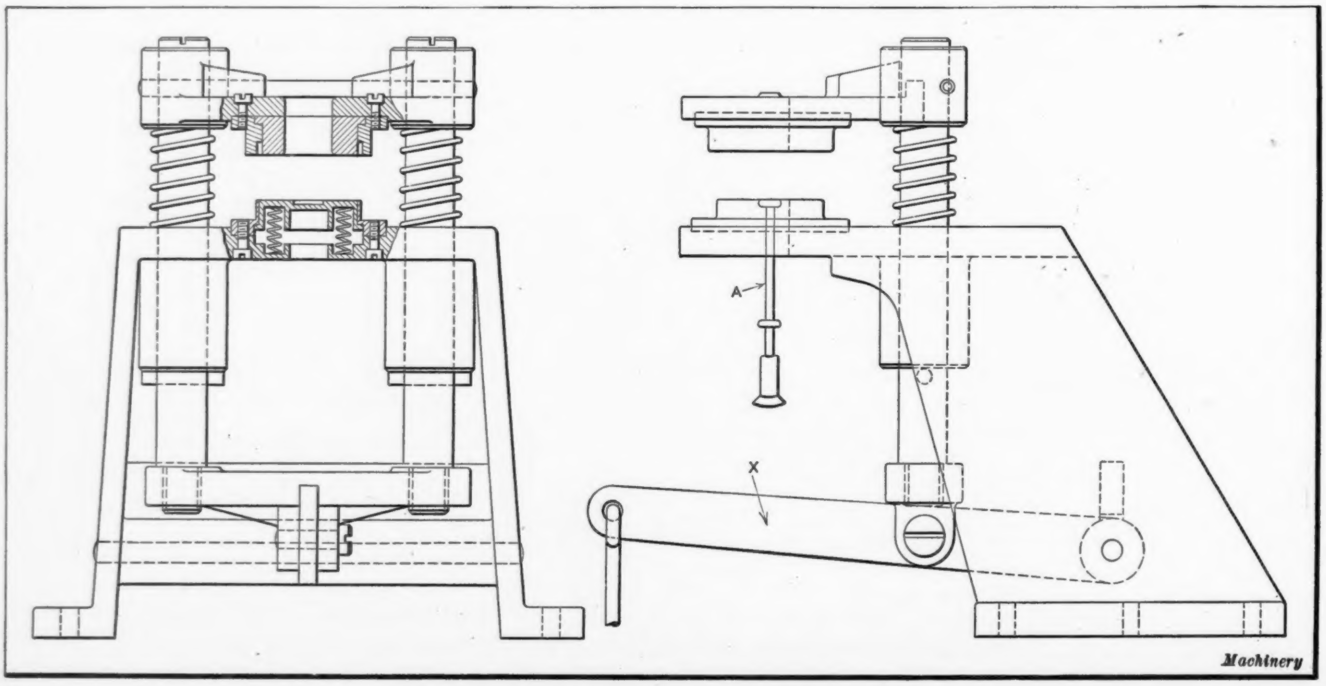

Fig. 31. Machine used for bending Hooks when inserted

certain intervals to give the proper spacing for the hooks. This movement is effected by a Geneva motion. The length of stroke can be regulated by the adjusting screw *L* while the straightener is regulated by the screw *P*. *F* is the thumb-screw used to open the jaws for loading and unloading, and *K* is the driving pulley. The position of the needle flame is shown at *R*. After the hooks have been inserted they are bent by the fixture shown in Fig. 31, the stem being inserted in the bending die as shown at *A* and bent by pressure on the foot-treadle which is connected to the arm *X*, thus operating the plunger carrying the die. A fixture of this kind is used for bending wires from 0.010 to 0.014 inch outside diameter. When the wires are from 0.003 to 0.005 inch outside diameter, a different type of fixture is used as indicated in Fig. 32. The construction of the fixture is simple, and the operation will be apparent by reference to the illustration; it will be seen that the device is hand-operated.

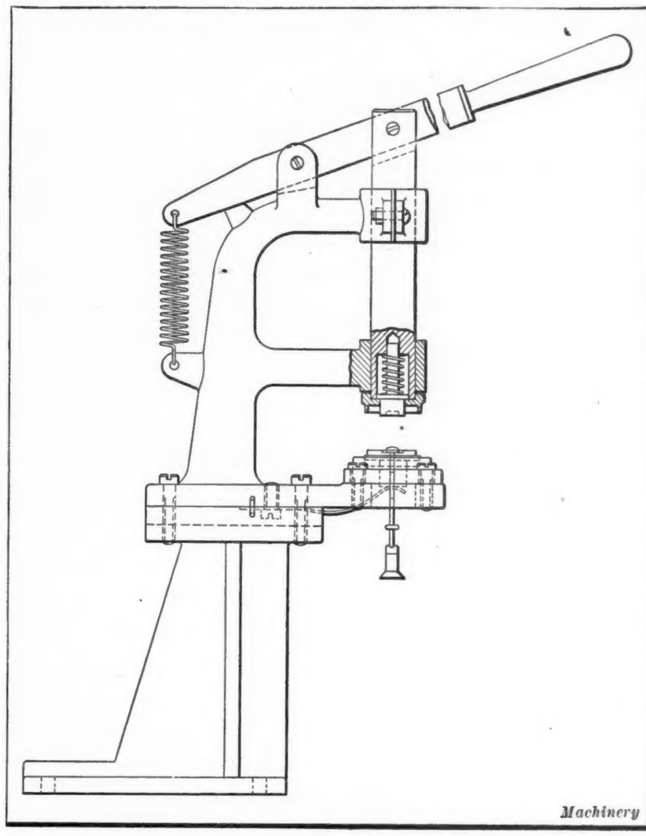

Fig. 32. Hand Fixture for bending Small Wires

Bump-testing Operation for Lamps

In order to see how long lamps will last under current while being vibrated and knocked against, the lamps are given a durability test so that it can be determined whether they are suitable for use on street cars or other vehicles having considerable vibration. Referring to Fig. 33, it will be seen that the lamp is placed in a regular socket on the rod *A*, through which electric wires are passed to furnish the necessary current for lighting the bulb. The fixture can be turned into any position, being pivoted at *F*, so that the lamps can be burned when they are tipped up, tipped down, horizontal or at any other angle while burning or vibrating. The cam *C* revolves at the rate of from 100 to 225 R. P. M. and causes the shoe *D* to move up and down and to drop off the shoulder on the cam, thus allowing the rod *A* to fall until it strikes the adjustable stop *E*. The position of this stop determines the amount of "bump," and it is evident that various settings can be easily obtained. This is one of many methods used for testing the durability of lamps. After the stems and lamps have been finished, they are loaded on special trays, as shown in Fig. 34, which are made so that they can be placed on top of each other and easily handled by the projecting ends *B*. The bulb and stem trays are of similar construction except that the bulb trays are provided with holes as indicated, while the stem trays have fiber pegs as shown at *C*.

It will be seen from the foregoing description of the methods of manufacturing tungsten lamps that every operation which can be, is handled by an automatic machine, while for operations of such a nature that a machine is not practical, special tools or fixtures of many kinds are devised to make the lamp manufacturing cost very low. In addition to the operations mentioned, there are tests of burning the finished lamp, inspecting operations, etching, labeling, boxing, etc. Also in addition to the "bump" test mentioned in the article, the lamps are burned for "life" tests. The "bump" tests used are of different kinds; sometimes an entire box of lamps is rolled from the top of a three-story building to the basement, and if the lamps do not break under this severe test, it shows that they are suitable for use in street cars and other service of similar nature, and that they can be shipped with safety to any part of the globe. The output of the Hungarian factory in which these processes were developed is from 25,000 to 28,000 lamps of every kind per day.

* * *

A great deal of statistical matter has been published on the amount of iron ore known to be available, and it is generally believed that the United States Steel Corporation controls the greatest amount of tonnage available in the Western hemisphere. This is not true. The Nova Scotia Steel & Coal Co. owns the Wabana mine on Bell Island in Conception Bay, Newfoundland, in which it is estimated there is between 2,000,000,000 and 3,000,000,000 tons of hematite ore. The deposit is probably more than double the holdings of the United States Steel Corporation, which are estimated to be about 1,300,000,000 tons. The quality of the ore is very rich, averaging 51 to 53 per cent pure iron in the three seams worked. Bell Island is only two miles wide by six miles long, but mining operations are being carried on beneath the sea, the holdings of the company in fact being greater beyond the shore lines of the island than on the island itself.

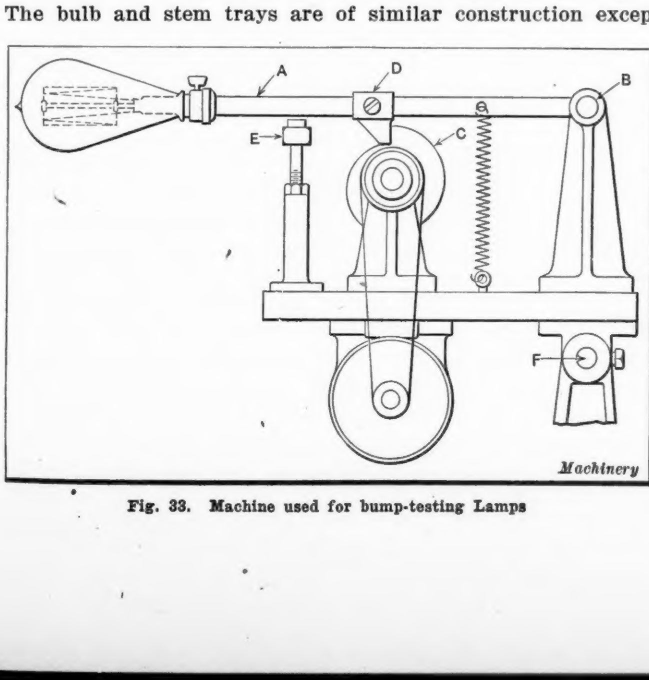

Fig. 33. Machine used for bump-testing Lamps

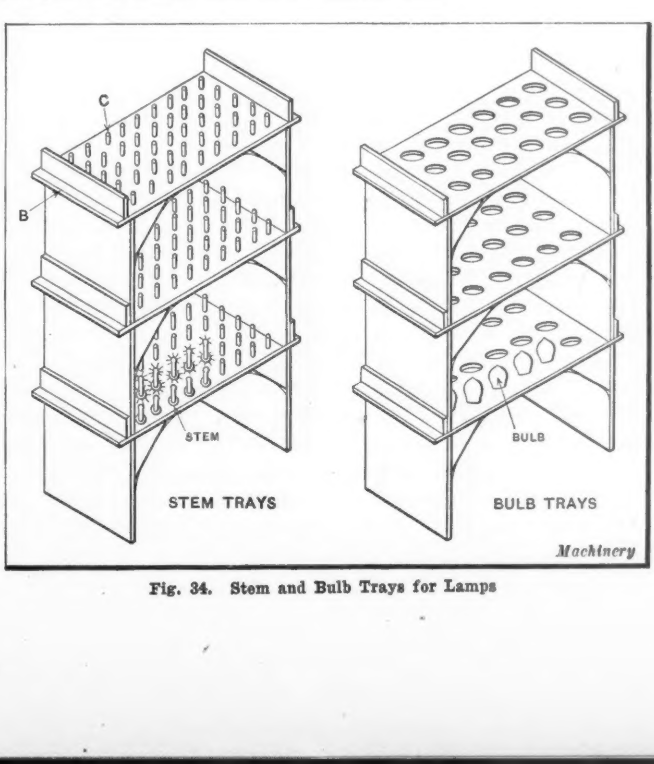

Fig. 34. Stem and Bulb Trays for Lamps

WHAT IS THE MATTER WITH THE MUNITIONS MAKERS?

FAULTS OF ORGANIZATION—LACK OF COOPERATION BETWEEN HEADS—EMPLOYMENT OF LABOR—WAGE DIFFICULTIES

BY FRED H. BOGART

THAT something is the matter with the munitions makers has passed the point of worth-while discussion. Twelve to fifteen months ago, the finger of pride was being directed from all over industrial America toward certain new corporations created for the sole purpose of handling contracts for munitions for foreign governments. Attention was drawn to them partly because they were, in most cases, backed by some of the largest and soundest manufacturing corporations in the United States (which was assumed to assure success in anything that should be undertaken), but more particularly because the contracts for war materials called for such rapid execution as to stagger all preconceived ideas as to what was possible of accomplishment in the creation of an organization, and the planning, building, equipping and manning of a plant for the mechanical production of such materials. Yet in every case this seemingly impossible task was just what was going to be accomplished.

In directing public attention to the stupendous money value of these contracts, to the name and character of the financial interests through whose hands the business passed to the manufacturers, and to the names and achievements of the manufacturers who had been awarded large orders, no opportunity was overlooked to center the public gaze on the miracle that must be performed to meet the deliveries agreed upon, and to emphasize the fact that such leading industrial organizations as had been selected alone had the size and breadth of organization and the financial stability to warrant undertaking the performance of such a miracle. And for a time it seemed that they were going to make good. Almost over night, acres of scrub farm land and boggy river meadows were cleared, leveled and covered with a network of tracks. Another week, and a continuous stream of freight cars loaded with foundation and building materials was being shunted in on those tracks and unloaded at high pressure. The manner in which many of the munitions plants grew from these materials and the speed with which the buildings, in every detail of equipment, were rushed to completion will long stand as a miracle of accomplishment. As soon as the buildings were completed, in some cases while they were incomplete, the installation of power equipment and machine tools began, and a few weeks later the public was informed that workmen were being hired and the plants were ready to begin active operations.

This marked the status of a majority of the big contractors somewhere between October 1, 1915, and January 1, 1916. To be sure, most of these manufacturers had announced some months before that actual delivery of finished product would be begun probably by November 1, and in no case later than January 1. However, certain uncontrollable conditions, known and appreciated by everyone acquainted with the machine tool market in 1915, had held back their equipment and had caused some delay; but this was of only momentary importance, as a sufficient factor of safety had been allowed in the purchase of equipment to permit of catching up with deliveries in a very short time when things were once under way.

Since then from ten to twelve months have passed in which no miracle of production has been accomplished by these new organizations. During this period millions of dollars' worth of war materials have been exported, but of this a comparatively small percentage has been ammunition or arms; and of the exports in these, the greater part has been produced by manufacturers who had had experience in the line of work contracted for and simply broadened an existing organization to cover the requirements of the new business, or by comparatively small manufacturers who were able to apply their mechanical experience in somewhat similar work to the problems of munition making with success. By the plants specially organized and equipped for the production of ammunition and small arms, comparatively nothing has been produced which is acceptable to the inspectors of the contracting governments, and which, in consequence, can be rated as salable product. On the contrary, very discreditable rumors have been leaking, first into the trade and lately to the general public, of gross inefficiency in their operation, of abuses and wastage in all departments of their organization, culminating, as one might expect, in a general accusation of mismanagement. The term "mismanagement" is the easiest in the world to apply to any organization from which the results are not up to promise or expectation, and as freely tossed about in casual conversation, it means absolutely nothing. Likewise, it is the easiest thing in the world for an outsider to view the result that to his mind is evidence of mismanagement and state what he would have done had the initiative been his. But such freely formed judgments amount to nothing unless they can be followed by a specific proof of error in judgment and a definite placing of responsibility for that error. It is a comparatively simple task to dig up proof of error in judgment in any concern, and even within the organizations of the munitions makers themselves it is an admitted fact that such errors have been and are being made; but the questions that come up at every conference on the matter, and the questions that must be correctly answered before the trouble can be remedied, are: "Where is the cause? Who is to blame?"

It is assumed at the outset that the trouble with these plants is in their mental equipment. Certainly the trouble is not due to the inadequacy of the plants, because in most cases they are ideal for the purpose and far advanced in details for small economies of manufacture over the average of the large American industrial plants. Neither is it due to poor or inefficient equipment, because the equipment, as a whole, is known to be of good construction and mostly new. Moreover, as every recent visitor to any of these plants will have observed, there is in nearly every department a large percentage of the equipment that has not yet been operated, or which is not being operated through lack of tools or operatives. This would seem to put the question squarely to the organizations to discover within themselves where the fault lies.

The suggestions submitted in the following paragraphs are the result of observations covering nearly a year spent in minor positions in the producing organizations of two of the large munitions plants. The constant migration of employes between these special plants and the relation of various experiences by these floating employes make it certain that internal conditions in these two plants are about on a par with the others of the group; this leads to the belief that the basic mistakes of all have been similar. These suggestions are not offered as an answer to the query heading this article, but are merely the logical conclusion of one viewing conditions from the standpoint of a common workman.

Organizations Based on Personality, not on Mental Efficiency

The point of vital weakness in these munitions organizations is that they are based on personality and not on mental efficiency. To place the blame for this would necessitate going far back and attributing to some human mind a foresight well-nigh supernatural. The big contracts for munitions fell into the hands of giant corporations because it was believed that they alone had the resources, the prestige, the driving power and the organization measuring up to the requirements necessary to get these gigantic industries into operation within the time limit. In the first three elements they were gaged correctly, and all three were needed to provide the material and mechanical equipment necessary to start production. But unfortunately for the ultimate success of these enterprises, the basis of organization of the parent plants was not suited to the demands of a manufacturing organization of such complex detail as is required to produce munitions to specifications.

It is a well recognized fact that, while some of our large industries, whose foundation dates back two generations, have grown into the class of big business, their organization is the same family affair that it was in the days when "the old man"

walked up and down through the shop in his shirt sleeves, calling everyone by his first name, and basing his driving power on the personal allegiance of his employes. Out of these old-time fellow-workers and friends, the department superintendents and foremen of today have been developed—every man familiar with his job because he has grown up in it and all with the idea of loyalty to the executive head firmly fixed as a principle of employment. It is obvious that such an organization owes its stability to its gradual development by the natural workings of the laws of selection, and that its producing power lies in each branch of the organization doing over and over the one or few things it has been trained to do.

The munitions contracts called for the manufacture of certain metal parts and composite devices generally unfamiliar to American mechanics, but for the production of which very complete and specific directions were given, down to the most trivial details. Obviously, it was a problem of detailed mechanical analysis requiring a mental organization based upon proved experience and efficiency, carefully designed and constructed to fit every requirement of the specifications. And because the task was of definite proportions and called for speed above everything, it required an organization in which previous faithfulness in other lines, personal friendships, inside pull, and all such qualifications played no part whatever.

In the specially organized plants, as they stand today, fully 50 per cent of the executive positions are held by men who, because of their previous success in handling departments in which they had grown up, or because they have exhibited commendable loyalty on occasion, or possibly for no other reason than that they "belonged," have been lifted out of the parent organizations and placed in positions requiring mechanical refinement as far removed from their previous line of work as a dividing head is from a threshing machine. If this 50 per cent had been a latent factor, merely reducing the mechanical effectiveness of the organization to what was represented by the remainder, the result would not have been so disastrous. But the habit of acquiring a personal following, which was the basic principle in the school of organization in which these men were brought up, followed them into the munitions plants and has proved their greatest drawback. It is the isolation of certain productive groups in these plants, headed by a leader whose power rests on service of a certain character to executives higher up, that has, from the moment these plants were ready to begin active operation, cut their productive capacity to such a small proportion of the normal expectation, considering the equipment used and the number of operatives employed, as to set even the executives themselves to wondering what all the wages had been paid for and what had become of the product.

Results Obtained by This Organization

The direct consequence of this grouping of forces, without regard to the laws of organization, has been three-fold: First, it has resulted in the development of so-called productive organizations without head or tail. From the top down there is no limitation of activity, no point at which an executive stops and leaves minor details in the hands of the proper subordinate; and from the bottom up there are no definite limitations of authority, no point beyond which a workman or minor official knows he may not go without passing the bounds of propriety and making himself liable to reprimand. On the contrary, high executives exercise authority down to detail instruction to operatives on machines, without intermediate knowledge or later notification; and these same operatives, not receiving "satisfaction" at the hands of their foremen, or superintendent, carry their troubles, in some instances, to the manager's office and get a hearing, if nothing more.

Second, the organization thus obtained has blocked every effort that has been made to work in at any point an effective productive sub-organization. In these large plants, an isolated organization, even if it is a perfect working unit, is helpless unless it has the cooperation of those coordinate units that are a necessary part of operation on a large scale. For instance, a foreman of a section of automatics might try to make a record in his department. He might clean house, get together some experienced men (if allowed to go so far), and be in shape to turn out a normal production. His actual output, however, will depend on how promptly the stores department supplies him with stock, how quickly his motor is repaired when it goes wrong, his belts mended when they break, his machines repaired in case they break down. In addition, he is absolutely dependent on the tool department for the special tool equipment required on his machines. It is here that nearly all the aspirants for production honors fail, because if any department foreman shows sufficient activity to attract particular attention, his supply of tools is usually purposely curtailed.

Finally, this organization has sidetracked the best mechanical experience and ability into a condition of practical inactivity, and substituted men of very limited mechanical experience, who have in some manner exhibited qualities that gave them the reputation of being "live wires." The very speed that was demanded on these munitions contracts has operated to the detriment of the qualified mechanic, and immensely to the advantage of the mechanical faker and grandstand player. The skilled mechanic, even though he may never have seen a shrapnel shell or a fuse component, knew after a few minutes' study of the detail prints that the production of such parts to such specifications was an extremely complex proposition. Such a mechanic, when any phase of the problem was presented for his solution, went at it with deliberation and painstaking thoroughness, because experience had taught that therein lay ultimate success. Immediately he was classed as a pettifogger and putterer, his "dawdling methods" were condemned as too slow, and eventually his effort and experience were set to one side to make way for the slam-bang production man, who could "make a showing." His "showing" will be found in various scrap piles representing an expenditure of several millions of dollars—monuments to high-speed production and the lack of mechanical refinement.

Familiarity with Product Preferred to Familiarity with Mechanical Construction

Another element in these munitions organizations that, in view of results obtained, would seem to be an error in selection is the employment in various responsible positions of men whose sole qualification is their familiarity with the use of munitions. It has been assumed, in other words, that because a man could sight a rifle or shoot a cannon, he necessarily must have had experience that would prove valuable in the manufacture of the materials familiar to his hands. In some few cases this familiarity has proved valuable; but in all departments producing exclusively machined metal parts to blueprints, executives so chosen have proved worse than useless. They have set up a line of experience counter to the specifications which is constantly at war with the requirements and the personal judgment of the foreign inspectors. A department superintendent, seeing the matter from a broader viewpoint than the majority, expressed himself in this manner: "I used to think I knew something about fuse work, but everything I attempt to do the way I think it ought to be done gets me into trouble. I have discovered that the only way to make headway in this work is to find out what the foreign inspectors want and then do it that way, whether I think it is right or wrong." This clear-cut statement, which is only another way of expressing a decision to adhere to the strict letter of the specifications, offers the key to the relations as they exist today between certain elements of the producing force and the representatives of the foreign governments. If such decisions had been so general as to create a definite policy in these plants, this relationship would be uniformly pleasant and cooperative. But a limited and ofttimes incorrect understanding of the function of certain parts has made it common practice to let down from the specified requirements whenever occasion offers, on the ground that such adherence to fine detail is nonsense in view of the manner in which the parts are to be used. Naturally, the practice has given rise to unending controversy over what one thinks is good enough and what the foreign inspector knows he must insist on.

Judging from the way this phase of the problem has worked out, it would seem that these specially equipped plants manu-

facturing munitions would be better off today and much farther advanced toward the satisfactory completion of the contracts if they had not known for what purpose the material being manufactured was to be used. These contracts for munitions were not a general specification to manufacture and ship so many rounds of ammunition or so many thousand rifles as per samples submitted. They were orders to produce, in American factories, certain war materials that were to be the exact counterpart of what had already been produced in various foreign countries for sufficient time to have developed their manufacture to a fine science. Every detail was specified in the most painstaking manner: the analysis of the materials used; the manner of examining and testing the materials; the dimensions of every component required, with the allowable variation from those dimensions; and the manner in which the parts were to be assembled, the various tests they were to be subjected to, and the basis of acceptance or rejection. Directions were given for everything—printed in a book, in fact—from the selection of the first pound of material to the manner of loading the finished product on shipboard for export. The only point in the whole contract requirements left to the discretion of the contractors was the choice of manner and method by which the specified parts should be produced. Reduced to its simplest terms, these contracts were an undertaking to manufacture a certain line of interchangeable parts to limits. This work is purely a problem in specialized mechanical engineering, and nothing more is demanded in its solution than the application of experience gained in the successful solution of similar problems in plants that have manufactured products of similar classification, though presumably for an entirely different purpose.

How many men with this sort of experience could be found in the munitions plants would be difficult to determine. It is certain that the percentage is very small, whereas the nature of the work and the record of the past year would indicate that, apart from the general business organization necessary to all such corporations, fully 75 per cent of the initiative should be in the hands of men of mechanical ability experienced in the production of small interchangeable parts.

Faults in Employment Methods Used

The two premises which have been set up and discussed in some detail are of vital importance, because they have their beginning in the foundation on which these organizations are based. If these premises are correct, dissection and discussion of minor faults and failures are futile, because it is reasonable to assume that they would all be corrected if the basic principles of organization were made sound and suited to the nature of the business. There is one outstanding feature of these munitions plants, however, that from the outset has been handled with a disregard for every principle of common justice and common sense.

For the conditions described, no single individual, probably no group of individuals, could be held accountable, as the organization of gigantic enterprises under new and strange conditions was a plunge into unknown territory, and naturally brought up problems which only time and a new line of experience could solve. But the administration of the employment departments of these plants reflects discredit on those that devised the system, and double discredit on those responsible for its continued use after it has proved inadequate, uneconomical, and susceptible to unlimited corruption.

In the creation of the labor departments of these plants, the same principle is applied to a minor department that governed the selection of the major organization. The identical methods of hiring, controlling, pricing, and paying employes that had operated successfully for the parent companies were in most cases installed at the new plants, without modification to meet the changed conditions brought about by the increased demand for labor. The necessity of grabbing up every applicant for employment to fill holes in the producing mechanism left no room for the exercise of judgment in their selection. The rule was to hire everybody, try everybody, and to hold on to everybody who possessed even a small percentage of the qualifications usually demanded of a desirable employe. Such a condition left no element of choice to the employer and gave the applicant the whip hand, because, secure in the knowledge that he would be employed for some purpose, he had everything to gain and nothing to lose by attempting to bluff himself into as well paid a position as possible.

Few if any of the plants have what, in the present state of industrial development, would be classed as an organized department of labor. Such organization as exists is represented by the assignment of certain functions of the department to an employment clerk and his assistants, to a chief timekeeper and a small army of subordinates, to certain designated superintendents, and finally to the manager himself. Applicants for employment present themselves at the outside employment office, and after giving certain personal facts are asked as to their experience, for purposes of "classification." The employment clerk has before him a schedule which reads somewhat as follows: Toolmakers, 45 to 60 cents; automatic operators, 35 to 50 cents and piece work; turret lathe operators, 30 to 45 cents and piece work; tool adjusters, 40 to 50 cents; machine operators, 25 to 35 cents and piece work; inspectors, 30 to 40 cents; laborers, 20 cents. The first figure is the minimum and the second is the maximum that a foreman or superintendent is allowed to pay new employes.

The existence of this schedule and, probably, the rates are well known to the applicant, because they had not existed for a month after the establishment of these plants before the system of classification was known for a radius of a hundred miles around every factory. Moreover, the applicant has probably been "tipped off" by some friend working in that plant, and has his "experience" learned by heart. The chief employment clerk may take this experience seriously, or he may question it. If the former, he fills in the classification and sends the man to the proper department to be placed and rated. If he questions the story the man tells, he sends the man to the department manager unclassified. But whether the man goes in classified or not makes little difference, as he tells the same story inside, and as there is no choice but to classify him, and no basis for judgment but his own story, he usually gets entered on the payroll at or very near his own estimate.

Under normal conditions, the rate will be fixed at the minimum for the classification and the rate card handed to the department timekeeper for recording. It may then pass successively to the department superintendent, the chief timeclerk, the general superintendent, and possibly the manager, to receive the official O.K.'s, and if it appears regular in every way, that is, if the rate fits the classification and the classification the department, it will probably be approved at every stage. Recommendations for a change in rate, or raises, go through a similar routine. The department foreman files a written recommendation giving reasons, and this passes through the same channels, requiring in some cases ten days to two weeks, during which time the employe is kept in doubt as to whether the increase is to be granted. Such, in brief outline, is the system of employment under which these munitions factories have developed their working force. If every applicant for a position were truthful as to his qualifications and every foreman to whom the authority is given to fix rates and classifications were honest in his service to his employer, the system would possibly meet every requirement. But the least desirable among the applicants for positions are the ones who have been informed as to the classes and rates paid, and these unblushingly represent themselves as experienced in the highest paid classifications. The foreman to whom they are sent knows perfectly well that they are falsifying, but to what extent he can judge accurately only by trial. He has been told to hire men. Such applicants will not lift a finger until they are classified and rated on their own terms, so the foreman, no matter how good his intentions may be, has no choice but to take the man at his own valuation.

It will be apparent that such a system of classification is open to abuse by dishonest or negligent foremen. There is no limit to the point to which the classification of any new employe may be boosted, so long as employes of that class are used in that particular department. In certain of the plants the departments are large, the department organizations are constantly expanding, and it is the easiest thing in the world to classify for any rate without any questions being asked as

to whether such men are actually needed. The result is just what might be expected. Departments are top-heavy with favorites classified and rated to the limit, and in a majority of instances men with mechanical experience are doing all the hard work, while others less worthy are getting the pay. If this meant merely the carrying of a few deadheads on the payroll of each department, its effect would not be serious, but every man in the department is "wise," and the net result is a what's-the-use-of-trying spirit not conducive to the highest productive efficiency.

It will be noted that there is no provision made in this system to detect "repeaters." All applicants must pass the employment clerk, but he is personally not on duty all the time and his force of assistants is constantly changing. This makes it possible, as is actually happening all the time, for men leaving the plant for better jobs elsewhere to come back in a few days and be hired again, often at a higher rate than before; for men to quit in one department and be hired in another where the rate for certain work is higher, or where it is possible to secure piece work; for men that were discharged for cause to be hired in another department in a few days, either under their own or an assumed name; for men to get themselves fired from a low-price job and be hired in a few days, in the same department, at a higher classification and rate. The ease with which men may be hired repeatedly by the same company has caused another abuse of authority to grow up, which in some cases is worked to good purpose. The difficulty of getting raises put through, due to the many O.K.'s required before the chief time-clerk can make them effective, was the means of losing a great many good men until the foremen hit upon a scheme of beating the raise check to it. Their plan now is to discharge good men on Friday afternoon or Saturday morning and hire them back on Monday, when they are reclassified and rerated. Where a raise had been refused and the reasons given for the refusal were not satisfactory from the foreman's viewpoint, it has been customary to double the increase over the recommended raise, just to add an element of humor to the situation.

However, in dollars-and-cents value, all the abuses described and imaginable under the fixed-rate-per-hour system are as nothing compared with the money being thrown away in these plants on piece work. There seem to be two separate causes for the almost inconceivable wages certain classes of men have been able to draw from these plants: First, the setting of piece-rates before jobs were developed. Primarily, this was due to lack of experience. Many of the men placed in charge of lathe operations, such as boring, turning, facing, etc., had no experience on which to base judgment as to how fast such operations ought to be done. Consequently, they started the operations with machines in a low state of efficiency, tools (often of carbon steel) that were of crude form and poorly hardened, and from the first output under such conditions they made production tables and fixed piece-rates. The result was that, when these same jobs reached a condition approaching normal operation, the earning power under the piece-rate granted often totaled from two to four times what a fair wage for the work would have been. The second cause has been the laxity of inspection from operation to operation. This has made it possible for piece-workers to crowd through defective work, which would be credited them, paid for, and lost sight of in the general scramble, before the defects would become apparent. To see some of these highly paid piece-workers in action, and to watch their sledge-hammer methods of gaining speed of output without regard to the life of the equipment, would drive the average mechanic into a state of nervous collapse.

The examples cited and the weaknesses disclosed are more than sufficient to condemn this whole employment system as a relic of a former industrial period, entirely inadequate to meet the requirements of present-day conditions. It takes no flight of the imagination, moreover, to picture what a legacy of industrial unrest and distorted values will be handed down to the "legitimate" manufacturing industries by these gigantic special plants—in which, in the course of their existence for the purpose for which they were organized, there might easily be employed upward of a hundred thousand mechanics—unless there is effected by the munitions makers, and this very promptly, a revision of method that will bring about normal conditions of employment and wages.

Remedies for These Faults

Such a general disclosure and discussion of some of the faults of the munitions plants would hardly be complete if it failed to be constructive to some degree. Yet to point out what is necessary to be done in such circumstances to correct every evil is no simple task. There is such a clearly defined operation of the law of cause and effect between some of the salient features of these organizations and the inefficiency that has resulted from their administration that certain corrections suggest themselves. These organizations should have been based solely on experience and efficiency. To what extent the established principles of scientific management could be used in the development of such an organization could be determined only by careful analysis; but it must be borne in mind that the filling of these contracts was in the nature of a 100-yard dash, while the side organization necessary to the operation of scientific management, and the investment involved in its installation, makes it better adapted to a two-mile run.

In whatever form such an organization might be worked out, there are two essential elements required to get results which will be found to characterize every effectually organized force, whether its basis be "scientific" or just sound business sense: First, the organized initiative must be capable of being plotted; that is, there must be a definite structure indicating the radiation of authority from the chief executive to every department head and subordinate, and this distribution of authority must follow a consistent line of descent from subexecutive to subordinate, with no doubling-up and no loose ends. Second, there must be no overlapping of authority, but definite limits set, above which minor officials may not go and below which high officials will not directly interpose. The principle that "a man cannot serve two masters" is as much a law of business organization as of ethics, and wherever one finds smooth-working efficiency of operation, he will find every man with one boss and with no uncertainty as to who it is.

It is well within the limits of probability that if some of the scrambled organizations in the munitions plants, as they are constituted today, were reconstructed with these two principles in mind and adhered to, their efficiency, with the same personnel intact, would be increased 100 per cent. The weak spots and leaks in the labor organization are not so complex, and it seems nothing short of criminal negligence that these have been allowed to continue so long. All that the circumstances require is the adoption of all or even a part of the features of a half dozen modern systems of employment in use in American factories, and of which the details are commonly known.

This matter of employment and wages assumes tremendous importance, because of its influence on such a large proportion of the workmen available for the mechanical industries and the effect this influence is to have when these special plants have completed their contracts and turned the men loose on a normal labor market. The success or failure of these plants, whether they make the tremendous profits they expected or sink their earnings in ineffective operation, is not a matter for general public interest. But the fact that their methods are heading tens of thousands of young men toward social bankruptcy, through the establishment of false standards of values and expensive personal habits that cannot be maintained when conditions return to normal, is a matter for deep public concern.

* * *

PRECISION GEAR CENTER GAGE—CORRECTION

In the description of the use of the "Precision Gear Center Gage" which appeared in the October number an error appeared relative to the required dimensions of the graduated collars. The graduated collars for measuring a center distance of 5 inches would, of course, require a radius of 3 inches and 2 inches, respectively, instead of diameters of 3 inches and 2 inches, as stated, in order to measure a center distance of 5 inches.

AREA OF SEGMENT OF CIRCLE

BY J. J. CLARK[1]

The mathematical formula expressing the area of a segment of a circle is simple in form and is easily derived. Thus, referring to the accompanying illustration:

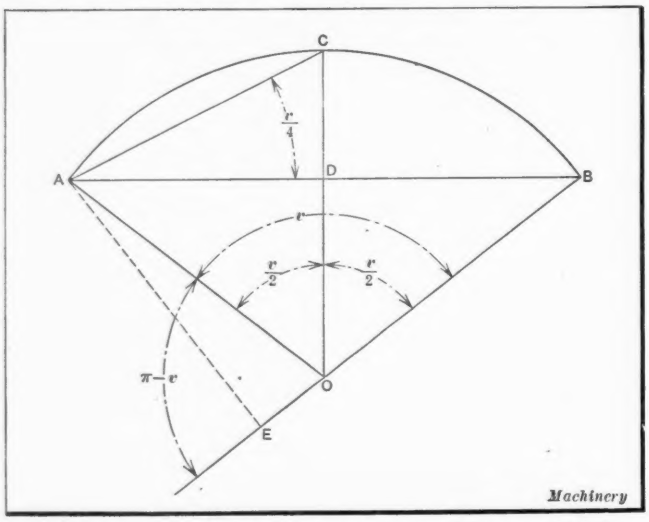

Diagram illustrating Method of calculating Area of Segment of Circle

Let $ACBDA$ be any segment;

A = area of segment;

v = central angle AOB;

r = radius $OA = OC = OB$;

c = chord AB;

h = height of segment = CD;

l = length of arc ACB.

Then, when angle v is expressed in radians:

$$l = rv$$

Area of sector $AOBC$ is:

$$AOBC = \frac{rv \times r}{2} = \tfrac{1}{2} r^2 v$$

Area of triangle AOB is:

$$AOB = \frac{OB \times AE}{2} = \frac{r \times r \sin(\pi - v)}{2} = \tfrac{1}{2} r^2 \sin v$$

Therefore, area A of the segment is:

$$A = \tfrac{1}{2} r^2 v - \tfrac{1}{2} r^2 \sin v = \tfrac{1}{2} r^2 (v - \sin v) \qquad (1)$$

To apply Formula (1) when v and r are known, and v is expressed in degrees, minutes and seconds, reduce the minutes and seconds to a decimal of a degree and then multiply this number of degrees and decimal of a degree by 0.01745329252, using one more significant figure than there are significant figures in the number denoting the angle. Except when exact results are required, the number of decimal places in the angle should not exceed three or four at the most. For instance, 43 degrees, 19 minutes, 32 seconds = 43.326 degrees, very nearly, and 43.326 × 0.0174533 = 0.75618 radian. If, however, the chord and height of the segment are given, which is usually the case in connection with shop problems, then (referring to the illustration):

$$\text{Angle } CAB = \text{one-half angle } COB = \frac{v}{4}$$

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$$\text{Tan } CAB = \tan\frac{v}{4} = \frac{CD}{AD} = \frac{h}{\tfrac{1}{2}c}$$

$$\text{Tan}\frac{v}{4} = \frac{2h}{c} \qquad (2)$$

Formula (2) gives one-fourth the angle, and this multiplied by 4 gives angle v, from which may be found the number of radians in this angle; its sine may then be looked up in a table of natural trigonometric functions. The radius r is:

$$r = \frac{\tfrac{1}{2}c}{\sin\frac{v}{2}}$$

It may also be calculated from the formula:

$$r = \frac{c^2 + 4h^2}{8h} \qquad (3)$$

Numerous approximate formulas have been published for finding the area of a segment; but many are incorrect for very large angles when they give good results for small angles, and *vice versa*. In any case, if results are desired that will be correct to, say, five significant figures, the calculation is quite laborious and chances of making mistakes are numerous. Hence, the writer has calculated a table presented in this connection, by means of which the area of any segment may easily be found. This table gives values of constant k in the formula:

$$A = kch \qquad (4)$$

The columns headed m contain values obtained by dividing height h by chord c; that is, $m = \frac{h}{c}$.

The columns headed k contain values corresponding to m in the preceding column. The columns headed d contain values to be used in finding k when the value obtained for m is not found in the table. For example, let m be the value obtained by dividing h by c. If this value is not contained in the table, note the next smaller value (which we will call m_0) and the corresponding value of k, which we will denote k_0. Let k denote the value sought; then:

$$k = k_0 + (m - m_0)d \qquad (5)$$

In Formula (5), d is the value in the column headed d that falls midway between k_0 and the next succeeding larger value, k_1. Suppose h = 10 5/64 inches and c = 32 3/8 inches: Then m = 10 5/64 ÷ 32 3/8 = 0.31129;

m_0 = 0.310 (see table);

k_0 = 0.71541;

d = 0.302.

VALUES OF CONSTANTS USED IN CALCULATING AREA OF SEGMENT

m	k	d	m	k	d	m	k	d	m	k	d
0.000	0.66667	0.002	0.125	0.67493	0.132	0.250	0.69890	0.254	0.375	0.73655	0.350
0.005	0.66668	0.008	0.130	0.67559	0.140	0.255	0.70017	0.254	0.380	0.73830	0.356
0.010	0.66672	0.014	0.135	0.67629	0.144	0.260	0.70144	0.260	0.385	0.74008	0.358
0.015	0.66679	0.018	0.140	0.67701	0.148	0.265	0.70274	0.266	0.390	0.74187	0.360
0.020	0.66688	0.024	0.145	0.67775	0.154	0.270	0.70407	0.268	0.395	0.74367	0.366
0.025	0.66700	0.030	0.150	0.67852	0.158	0.275	0.70541	0.274	0.400	0.74550	0.368
0.030	0.66715	0.034	0.155	0.67931	0.162	0.280	0.70678	0.278	0.405	0.74734	0.372
0.035	0.66732	0.040	0.160	0.68013	0.168	0.285	0.70817	0.282	0.410	0.74920	0.376
0.040	0.66752	0.046	0.165	0.68097	0.172	0.290	0.70958	0.288	0.415	0.75108	0.378
0.045	0.66775	0.050	0.170	0.68183	0.180	0.295	0.71100	0.290	0.420	0.75297	0.382
0.050	0.66800	0.054	0.175	0.68273	0.182	0.300	0.71245	0.294	0.425	0.75488	0.386
0.055	0.66827	0.060	0.180	0.68364	0.188	0.305	0.71392	0.298	0.430	0.75681	0.388
0.060	0.66857	0.066	0.185	0.68458	0.192	0.310	0.71541	0.302	0.435	0.75875	0.392
0.065	0.66890	0.072	0.190	0.68554	0.198	0.315	0.71692	0.306	0.440	0.76071	0.394
0.070	0.66926	0.080	0.195	0.68653	0.202	0.320	0.71845	0.310	0.445	0.76268	0.398
0.075	0.66966	0.082	0.200	0.68754	0.206	0.325	0.72000	0.314	0.450	0.76467	0.400
0.080	0.67007	0.086	0.205	0.68857	0.212	0.330	0.72157	0.318	0.455	0.76667	0.404
0.085	0.67050	0.094	0.210	0.68963	0.216	0.335	0.72316	0.322	0.460	0.76869	0.408
0.090	0.67097	0.098	0.215	0.69071	0.220	0.340	0.72477	0.326	0.465	0.77073	0.410
0.095	0.67146	0.102	0.220	0.69181	0.224	0.345	0.72640	0.328	0.470	0.77278	0.414
0.100	0.67197	0.110	0.225	0.69293	0.230	0.350	0.72804	0.334	0.475	0.77485	0.416
0.105	0.67251	0.114	0.230	0.69408	0.234	0.355	0.72971	0.336	0.480	0.77693	0.418
0.110	0.67308	0.118	0.235	0.69525	0.240	0.360	0.73139	0.340	0.485	0.77902	0.422
0.115	0.67367	0.122	0.240	0.69645	0.242	0.365	0.73309	0.344	0.490	0.78113	0.426
0.120	0.67428	0.130	0.245	0.69766	0.248	0.370	0.73481	0.348	0.495	0.78326	0.428
0.125	0.67493		0.250	0.69890		0.375	0.73655		0.500	0.78540	

Machinery

Consequently, $k = 0.71541 + (0.31129 - 0.310) \times 0.302 = 0.71580$.

The area A of the segment is:

$$A = 0.7158 \times 32\ 3/8 \times 10\ 5/64 = 233.55 \text{ square inches.}$$

This result is found by substitution in Formula (4).

If the chord c and radius r are given, first calculate the value of height h by the formula:

$$h = r - \tfrac{1}{2}\sqrt{4r^2 - c^2} \qquad (6)$$

If the height h and the radius r are given, first calculate chord c by the formula:

$$c = 2\sqrt{2rh - h^2} \qquad (7)$$

The following formula expresses the value of k very accurately:

$$k = 0.66667 - 0.00127m + 0.5545m^2 - 0.11563m^3 - 0.077m^4 \qquad (8)$$

Thus, for $m = 0$, $k = 0.66667$; for $m = 0.1$, $k = 0.67196+$; for $m = 0.2$, $k = 0.68755-$; for $m = 0.3$, $k = 0.71245-$; for $m = 0.4$, $k = 0.74551+$; for $m = 0.5$, $k = 0.78540+$. Note how closely these values correspond to those given in the table; in fact, by substituting this expression for k in Formula (4), we obtain the most accurate formula for the area of a segment that the writer has ever seen.

$$A = (0.66667 - 0.00127m + 0.5545m^2 - 0.11563m^3 - 0.077m^4)ch \qquad (9)$$

If m is greater than 0.500, the segment is greater than a semicircle. In such case, find the area of the other segment having the same base (chord) and whose height is $2r - h$; then subtract this area from the area of the circle, and the remainder will be the area of the segment sought.

The formula used for calculating values of k in the table is:

$$k = \frac{v - \sin v}{8m \sin^2 \dfrac{v}{2}}$$

* * *

ANNUAL MEETING OF A. S. M. E.

The annual meeting of the American Society of Mechanical Engineers will be held in New York City, December 5 to 8, inclusive, the Engineering Societies Bldg. being the headquarters. The president's address on the relation of education to engineering, by Dr. D. S. Jacobus, will be delivered Tuesday evening. On Wednesday morning, following the regular business of the session, there will be memorial exercises in memory of John E. Sweet, past-president and founder of the society. The technical papers to be presented follow:

"The Proportioning of Surface Condensers," by George A. Orrok.

"The Testing of House-heating Boilers," by L. P. Breckenridge and D. B. Prentice.

"Water for Steam Boilers—Its Significance and Treatment," by Arthur C. Scott and J. R. Bailey.

"The Utilization of Waste Heat for Steam Generating Purposes," by Arthur D. Pratt.

"Graphic Methods of Analysis in the Design and Operation of Steam Power Plants," by R. J. S. Pigott.

"Power Plant Efficiency," by Victor J. Azbe.

"Heat Transmission through Various Types of Sash," by Arthur N. Sheldon.

"Accurate Appraisals by Short Methods," by J. G. Morse.

"Productive Capacity a Measure of Value of an Industrial Property," by H. L. Gantt.

"A Gas Producer for Bituminous Coal," by O. C. Berry.

"Commercial Sampling and Gas Analysis," by P. W. Swain.

"An Investigation of the Internal Combustion Engine as Applied to Traction Engines," by A. A. Potter and W. A. Buck.

"The Ratio of the Specific Heats and the Coefficient of Viscosity of Natural Gas from Typical Fields," by Robert F. Earhart.

"Illustrated Review of the Werkspoor Marine Diesel Engines," by Thomas O. Lisle.

"The Impact Tube," by Sanford A. Moss.

"Heat-treatment of Wrought Iron Chain Cable," by F. G. Coburn, W. W. Webster and E. L. Patch.

"The Flow of Air and Steam through Orifices," by Herbert B. Reynolds.

"Clasp Brakes for Heavy Passenger Equipment Cars," by T. L. Burton.

"Mechanical Design of Electric Locomotives," by A. F. Bachelder.

"An Analysis of the Working Parts of Safety Valves Met with in Marine Practice, with Suggestions for Repairs and Improvements," by E. F. Maas.

"The Talbot Boiler," by Paul A. Talbot.

The machine shop session will be devoted to discussion of papers on the standardization of machine tools and on a classification of machine shop practice and a proposed plan of work of the sub-committee on machine shop practice. On Friday afternoon and Saturday morning there will be a public hearing by the boiler code committee.

* * *

APPRENTICES' SHOP PROBLEMS

BY JOHN G. BRUEGGEMAN [1]

When apprentices, while getting their shop training, receive, as well, a training in the principles of mechanics and the fundamentals of science and mathematics applying to their trade, it is remarkable how changed is their manner of approaching their work. Their interest is stimulated and their outlook broader, but particularly is their insight keener into the why and the how of their work.

The high school in Springfield, Vt., has a cooperative, or part-time, course in conjunction with the Fellows Gear Shaper Co., the Jones & Lamson Machine Co., and other machine builders of the city. During the last year of their four-year course, after they have had a grounding in mechanics, science and mathematics, the boys are required to submit, each time they are at school, several shop problems taken from their own or fellow-workers' experiences. The problems they dig up show what use they make of their training in analyzing methods and processes.

A problem that was submitted not long ago caused considerable discussion. The boys had about completed their course and were doing some good work in the shops. A boy who was operating a radial drilling machine in the special tool department was given a tool-block and a drawing, Fig. 1, showing a bolt hole to be drilled at 15 degrees to both the front and side faces of the block. Having received instruction in orthographic projection, he knew that if that bolt-hole were to appear as it did in the drawing, at 15 degrees to the front and side of the block, it would not be correct to tip the block 15 degrees both ways and drill. So, using a bevel protractor, he found the position in which the block should be placed so that the drilled hole would appear to make angles of 15 degrees with both the front and side faces of the tool-block. Then he brought the problem to school for a mathematical solution.

Several solutions were worked out in class. The simplest was by triangulation. The diagrams in Fig. 2 and the views in Fig. 3 will aid in making the solution clear. AB, A_1B_1, and A_2B_2 are front, side, and top views, respectively, of the hole through the block, which was 5 inches thick. According to trigonometry, $BC = 5 \times \tan 15 = 1.34$ inch. Obviously, B_1C_1 is the same as BC, so that the angle which B_2C_2 makes with B_2B must be 45 degrees. This is one angle through which the block must be revolved. As

$$B_2C_2^{\,2} = 1.34^2 + 1.34^2$$
$$B_2C_2 = 1.89 \text{ inch}$$

Therefore, a right triangle with AC (or A_2C_2) as the long leg and B_2C_2 as the short leg may be formed. The hypotenuse of this triangle will represent the hole through the block in its true position and length. The angle this line (A_2B_2 in the diagram) makes with AC (or A_2C_2) is the angle through which the block must be tipped vertically after being revolved horizontally through 45 degrees. This is the angle a in Figs. 2 and 3. The tangent of angle a is $1.89 \div 5 = 0.37800$. From a table of tangents it is found, therefore, that the angle a is 20 degrees, 42 minutes.

The table of the radial drilling machine on which this job was done could be revolved about a horizontal axis running through the center line of the table bracket, as well as horizontally about its own center. The tool-block could, therefore, have been clamped to the table with its front side parallel to the horizontal axis of the table; the table revolved horizontally through 45 degrees and then tipped in a vertical plane through 20 degrees, 42 minutes, and the hole drilled.

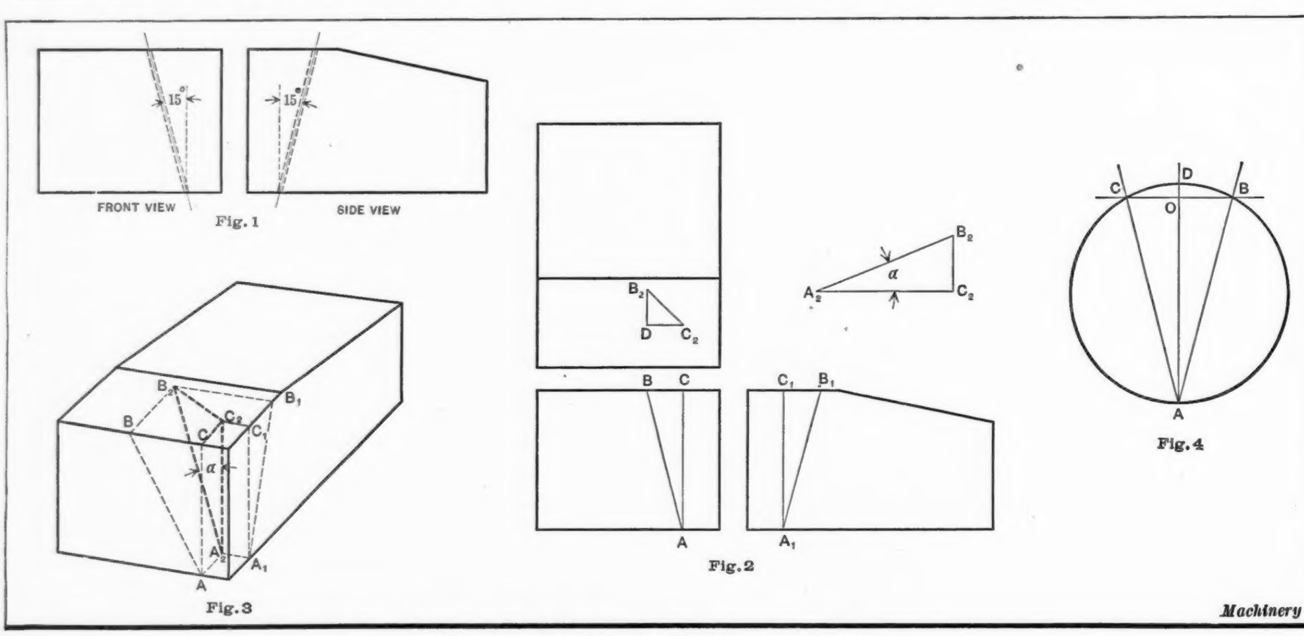
Not all the problems submitted originate with the boys; some are given to them by the older hands. For instance, one of the boys was given a piece to turn down to 12 inches diam-

[1] Address: Springfield High School, Springfield, Vt.

eter. As he had to know, in thousandths, how much stock remained for his finishing cut—since 12-inch micrometers were the largest available—he used the method of measuring the work and the geometric solution shown in Fig. 4. His foreman was responsible for the method of measuring, but the boy worked out his own results.

From a point A on the work he measured, with his 12-inch micrometer, to the two points B and C on opposite sides of the work. Then he measured the chordal distance BC, which was found to be 1 1/2 inch. The amount of over size was calculated from these measurements as follows: DA is the perpendicular bisector of the chord CB; BOA is then a right triangle with $OB = 3/4$ inch and $BA = 12$ inches. As $(OA)^2 = 12^2 - 3/4^2$, $OA = 11.977$ inches. Knowing that: "If through any point two secants are drawn to a circle, the product of the distances from the point to the two intersections on one secant is equal to the product of the distances from the point to the two intersections on the other," and reducing this to shop English: $OC \times OB = OD \times OA$, or $3/4 \times 3/4 = OD \times 11.977$. $OD = 0.047$ inch; therefore, $OD + OA = 12.024$ inches, the diameter of the piece, so that there still remained 0.012 inch on the radius to be removed.

Not all of the problems have a direct application to the work in hand; some spring, rather, from a wholesome curiosity of the boys. About the time that the class in mechanics was discussing forces and the principle of work, one of the apprentices, doing some chuck work on a turret lathe, and pulling quite hard on the end of a chuck wrench, became interested to know what he was putting on his piece of work in the way of compressive force to keep the work from turning in the chuck. Looking up the data on the three-jaw scroll chuck with which his machine was equipped, he found that the spiral scroll had a lead of 1/3 inch, while it took twelve turns of the wrench to turn the scroll once. As he was a husky lad, he thought that he must have been pulling about 100 pounds on the end of a 12-inch lever to turn the chuck screws. So, applying the mechanics' principle of work, he found 100 pounds $\times$ 12 inches $\times 2 \times 3.1416 \times 12$ turns $= F \times 1/3$ inch. Taking a short-cut by using 22/7 for 3.1416 and transposing, this gave $F = 100 \times 12 \times 2 \times 22/7 \times 12 \times 3 = 271{,}543$ pounds, where F is the force on each jaw of the chuck. Of course, the other two jaws had to push back with an equal force between them in order to keep the work from being pushed sideways; that is, to hold the work in equilibrium, so that the force F was the total compressive force to which the work was subjected. This is, of course, the theoretical load; what the actual force was is extremely difficult to say, as the power absorbed in friction in the chuck is difficult to determine exactly. The boy took the safe assumption, however, that about two-thirds of the 100 pounds was wasted in friction. Thus, the force F would be a third of the calculated force, or 90,500 pounds.



Figs. 1 to 4. Mathematical Solutions of Shop Problems

CASEHARDENING BRONZE FOR DIES

The bronzes which possess the greatest hardness lack the requisite properties for chasing and sinking fine intricate designs. It is, however, possible to obtain a hard face on a bronze by a process analogous to the casehardening of steel, and this is practiced with some bronze dies. The method is that of coating the surface of the die with pure tin, and then heating to a low red heat in order to alloy the tin with the surface of the bronze. As is well known, copper and tin unite in all proportions, and with from 20 to 30 per cent of tin the alloy becomes quite hard. The surface of the die to be casehardened is cleaned from grease by soaking in a strong hot potash solution and then immersing in a pickle or dip of acid to remove the oxide. A suitable pickle, which works more rapidly if hot, is made with five parts of water and one part oil of vitriol, and the die is allowed to soak in it for several hours until clean. It is then taken out and brushed, and the surface coated with a strong solution of chloride of zinc to act as a flux. The surface is then covered with pure melted tin. The tin may be melted on the surface by a soldering-iron, but by far the best method is to use a torch or a blowpipe. The tin is melted over the surface only, and as little as possible put on, as the fine detail of the die must not be filled up. The die is then washed in water to remove the excess of chloride of zinc flux, and the surface examined. If there are any portions which are not covered with tin, the process is repeated. The next operation is to heat the die to a red heat, preferably in a muffle, though a blowpipe or torch may be used. To prevent the surface from oxidizing, it is advisable first to cover it with a strong solution of boracic acid. The boracic acid is dissolved in hot water and the solution lightly brushed over the surface. A light coat only is necessary. The die is placed on an iron plate to keep it from breaking when heated, as tin-bronze becomes brittle at a red heat, and it is heated to a low red heat and allowed to remain in this condition for ten or fifteen minutes. The plate is then removed from the muffle and the die allowed to cool. The boracic acid is removed by soaking in hot water and afterward pickling if necessary. After the foregoing operations the surface of the bronze is quite hard and difficult to cut with a file. Dies hardened by this method can be used for stamping leather, soft metals, paper and similar work, as they can be made originally soft enough for chasing or sinking with ease, and then hardened without destroying the design. The best results are obtained by using a rather soft bronze mixture with as little lead as possible. Such a bronze, high in copper, is not likely to give trouble by softening or cracking during the heating. A mixture recommended for this work is: Copper, 88 pounds; tin, 8 pounds; zinc, two pounds; and lead, two pounds.—*Foundry Trade Journal.*

LETTERS ON PRACTICAL SUBJECTS

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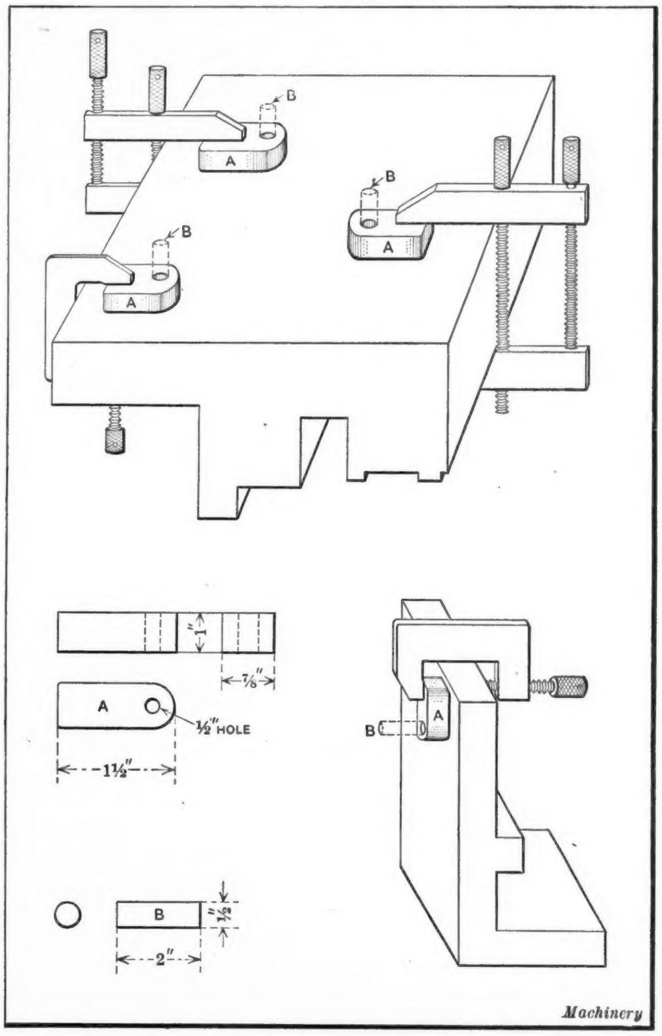
LOCATING HOLES IN JIGS AND FIXTURES

The accompanying illustration shows a time-saving method of locating holes in jigs and fixtures. Before this method can be used, however, it is necessary to make up a number of tool-steel blocks *A*, being careful to have both surfaces of each block exactly parallel, and the half-inch hole lapped to size and absolutely square with both surfaces. Then an equal number of pins *B* must be made up and ground to fit snugly in the holes in the blocks; also a number of bushings with



Locating Blocks and Pins for locating Holes in Jigs and Fixtures

various size holes, preferably varying by 1/64 inch down to 1/64 inch.

In use, the blocks are clamped lightly to the piece in which it is desired to locate the holes, with C-clamps or toolmakers' clamps, as shown, and the pins are inserted in the blocks. Measurements are taken across the pins with a micrometer, or an indicator from the surface plate, as the case may be, and the blocks are adjusted until the proper locations are found. The blocks are then accurately clamped, the pins removed, and the piece is taken to the drill press where the holes are drilled, using the blocks as drill guides. If the holes to be drilled are smaller than the holes in the blocks, the proper size bushing should be inserted; if the holes are larger, a half-inch hole should be drilled, the blocks removed from the piece, and the holes rebored with a pilot counterbore.

The blocks illustrated are for medium size work, but blocks should be made of the proper size to fit the needs of different work. Of course, this method cannot be used in all instances, but enough work can be found for it to effect a considerable saving. It is sufficiently accurate for more than 80 per cent of the jig work done in the average tool-room. In fact, its accuracy seems to be limited only by the expertness of the toolmaker. The writer has located, drilled and reamed three holes within a limit of 0.001 inch in 11 inches. If a set of correctly made blocks and pins is available, together with a flat drill properly ground and a micrometer of the proper size (or a dial indicator for surface plate work), it is an easy matter to keep the dimensions within a limit of 0.0005 inch. A properly ground flat drill having a round shank ground to fit the bushing is preferred for this work, as it does not have the same tendency to run off center as an ordinary twist drill has. A three-corner reamer is essential, too, for reaming the holes with the utmost precision.

Moline, Ill. H. W. JESPERSEN

MAKING 50,000 WASHERS IN AN HOUR

To make 50,000 stampings in an hour from one die seems almost impossible, yet it is easily done. Few people realize what a punch press can do when properly tooled and handled. There are hundreds of punch presses in operation today with makeshift, unhandy, inefficient tools that, with little change and slight expense, could be made to turn out considerably more work at no higher cost for operating. In one of Detroit's largest automobile factories, there are two presses working at 500 and 600 pieces an hour that could easily be made to turn out 2500 and 3000 an hour.

The die that turns out 50,000 washers in an hour is a sub-press die of the compound type with about a 3-inch ram laid out to cut five washers and their holes at each stroke. These washers are about 7/32 inch in diameter with a hole suitable for a No. 4 or No. 6 screw. The material is half-hard brass, No. 22 or No. 24 B. & S. gage, which is fed in rolls 1 5/16 inch wide and about 150 feet long. These rolls are made by running the regular roll sheet brass, which is 6 inches wide, through a set of gang slitters which cut the whole roll into strips 1 5/16 inch wide. The die is laid out to cut the first, third and fifth washers in the first row and the second and fourth washers in the third row back. This is done simply to avoid getting the five holes too close together, thus weakening the die and reducing its life.

The press used is a regular No. 3 punch press, but the stroke is reduced from 1 1/2 inch to 3/4 inch in order to reduce friction and to prevent the sub-press from overheating, which would be likely to occur were the longer stroke used. The No. 3 presses are designed to run at 100 to 125 revolutions per minute, but shortening the stroke makes it possible to use a very large pulley on the driving shaft and run the press at 190 revolutions per minute. Although this speed is excessive for a press of this size, in the present case it handles the work smoothly and easily. A double roll feed with 1/64 inch adjustment is used to feed the stock through the die; and as the strip comes out, it is rolled up on a reel. Later, the handy-man removes the washers by see-sawing the strips over a 3/8-inch rod placed in a box for this purpose. The center punching, or slug as it is often called, is punched through the die in the blanking operation; consequently no slugs are mixed with the washers. While $190 \times 5 \times 60 = 57{,}000$, which is the number of washers it would be possible to make in an hour should every stroke be caught, in the starting of each roll of stock there is a small loss of time, so that only about 50,000 washers are produced.

This sub-press die will cut about 1,000,000 of these washers without grinding, though sometimes more than 3,000,000 may be cut. The same die will cut half as many steel washers.

The dies do not deteriorate as fast as the ordinary progressive blanking die, neither do they cut at as fast a speed, because in blanking this size of washer in a progressive die (single blanker) a small No. 1 press with a standard stroke of 1 1/2 inch, running at 175 to 200 revolutions per minute, would be used. This means that the ram of the press or the punch is traveling at the minimum rate of 262 inches per minute. On the sub-press die the press has a stroke of 3/4 inch and makes 190 revolutions per minute, so the punch travels but 142 1/2 inches per minute. As a result, while the cutting speed is slower, the production is greater, and there is less wear on the sub-press die than on the common die. The reduced wear is due to the material being pressed back into the strip instead of being pushed through the die.

Ypsilanti, Mich. A. E. SANFORD

PLANER AND SHAPER GAGE

The accompanying illustration shows an L. S. Starrett planer and shaper gage to which I have added a vernier reading to 0.001 inch, which does away with the necessity of setting the gage with a micrometer and saves a considerable amount of time when numerous settings are required. I graduated a gage in this way by first tinning the edge with solder, after which the gage was set at 0.500 inch; a line *A* was then scribed on the slide and a line *B* on the base, a Brown & Sharpe vernier height gage being used for this purpose with edge *C* held vertical. The gage was then set at 1.500 inch and line *D* scribed to coincide with line *A*. Readings of the height gage were kept for both lines, and the difference was found to be 3.162 inches, which corresponds to 1 inch vertical movement of the slide. Distance *BD* was next divided into ten equal parts, and each of these subdivided into four equal spaces, making a total of forty divisions, each of which is:

$$3.162 \div 40 = 0.07905 \text{ inch.}$$

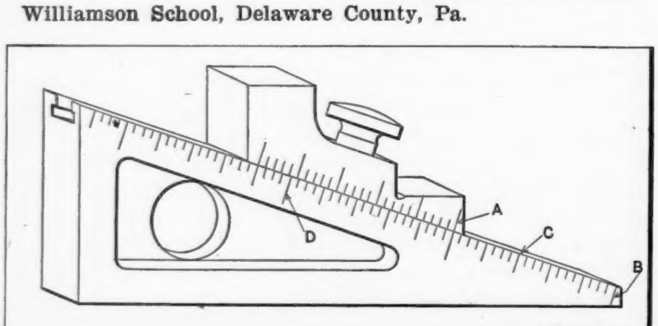
Twenty-five divisions on the vernier occupied the same space as twenty-four divisions on the scale, so that each vernier division is:

$$\frac{24 \times 0.07905}{25} = 0.07589$$

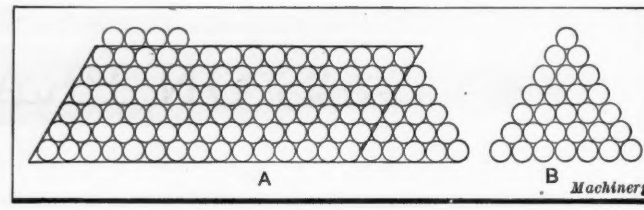
$$0.07905 - 0.07589 = 0.00316 \text{ inch.}$$

From the preceding, it will be evident that a movement of the slide of 0.00316 inch corresponds to a vertical movement of 0.001 inch on the slide. This is explained by the fact that the angle of the gage is 18 degrees, 26 minutes, and the sine of this angle is 0.3162, *i. e.*, a right-angle triangle with one angle of 18 degrees and 26 minutes and a hypotenuse 1 inch in length has an opposite side 0.3162 inch in length. To find the hypotenuse of a similar triangle with an opposite side 1 inch in length, divide 1 by 0.3162, which gives 3.162 inches. This verifies the preceding calculation. FREDERICK W. SNYDER

Williamson School, Delaware County, Pa.



L. S. Starrett Planer and Shaper Gage provided with Vernier Scale



Rapid Method of counting Tools

METHOD OF COUNTING TOOLS RAPIDLY

In the May number of MACHINERY, J. H. Crary presented a table for rapidly determining the number of shells or billets in a pile without actually counting them. His method may be rapid, but I believe my method is faster, as it is but a formula and can be computed mentally in an instant without referring to a table or blueprint. The method is as follows: Multiply the number of shells or tools in the top row by the number of rows, which gives the number contained in the parallelogram shown at *A*. To this result add the number of odd tools, if any, on top of the pile and the product of one-half the number of rows multiplied by one less than the number of rows in the pile. This gives the number of tools shown at the right of the parallelogram. This rule can be stated as a simple formula, as follows:

$$N = TS + \frac{S}{2}(S - 1) + O$$

in which

N = number of tools;
T = number of tools in top row;
S = number of tools in side row;
O = number of odd tools on top.

For example, in the case shown at *A*, $T = 15$; $S = 6$; and $O = 4$. Inserting these values in the formula and solving, the number of tools is found to be

$$15 \times 6 + \frac{6}{2} \times (6 - 1) + 4 = 90 + 15 + 4 = 109.$$

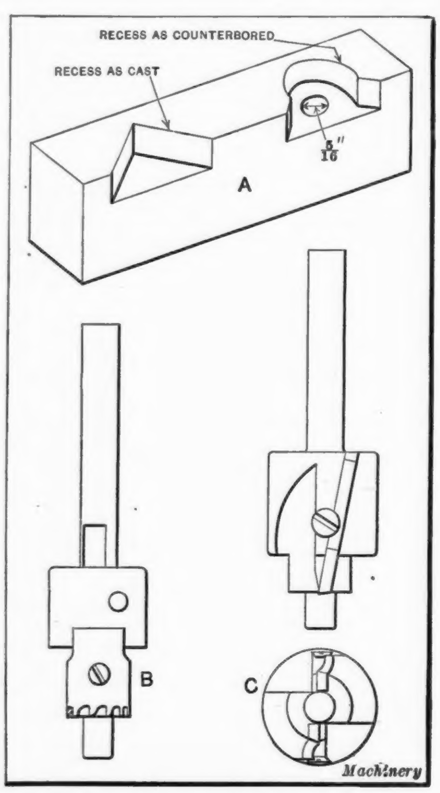
Should the pile have only one tool on top, as at *B*, add 1 to the number of rows, then multiply one-half of this sum by the actual number of rows; or, in the form of a formula, $N = S\left(\frac{S+1}{2}\right)$.

Substituting in this formula the value of S shown at *B*, or 7, and solving, the number of tools is found to be

$$7 \times \frac{7+1}{2} = 7 \times 4 = 28.$$

Cleveland, Ohio. L. N. FROST

HEAVY-DUTY COUNTERBORES FOR SMALL WORK



Heavy-duty Counterbores for Use on Castings and Steel

Two counterbores which stood up remarkably well under severe service are shown in the accompanying illustration; both of these have removable cutters made of high-speed steel. A piece of work before and after being counterbored is shown at *A*, from which it will be seen that there is a triangular-shaped recess cast in the piece which is subsequently counterbored. A small hole is required in the work, and advantage is taken of this fact to use a pilot to help support the tool. With the exception of the recess, each casting is finished all over before being drilled, and for certain reasons it was not found advisable to cut the recess from solid metal, even though the counterboring could have been more easily done in that way. The unbalanced condition of the tool, the blow which occurs as each tooth strikes the metal once during every revolution, the sand which remains in the corners after the castings have been pickled and tumbled, and the spotting on unbroken casting surfaces combine to make exceptionally

severe service conditions which the counterbores are required to meet.

Tool *B* is made with a carbon steel shank which extends right through the cutter and forms a hardened pilot, to which previous reference has been made. The driving head is fastened to the shank by a taper pin and transmits power direct from the chuck to the cutter. A drill press is used for the performance of this operation, which is fitted with a Hartford chuck, the two jaws of which extend beyond the body and engage the driving pins used on this counterbore. The cutter is made of a small piece of high-speed steel, which is flattened to fit into a driving slot in the head, where it is held by a small set-screw, the only function of which is to prevent the cutter from falling out. Owing to the uneven character of the cut, small teeth are used, which are spaced 1/8 inch apart, and these teeth are maintained throughout the life of the cutter by re-grinding them with a saucer-shaped wheel when they become worn down too low for sharpening. In order to maintain the diameter of the counterbored hole, the body of this cutter is turned straight on the outside, but the teeth have a slight clearance ground on them. One of these cutters averages 17,000 holes before it is completely worn out; and satisfactory results are obtained when running at 65 revolutions per minute.

Tool *C* was designed for use in counterboring 11/16-inch holes to a depth of 1/4 inch, the material being cold-drawn steel. It will be seen that this counterbore is furnished with two 1/8- by 3/8-inch blades and two screws to hold them in place; the body of the tool is made of machine steel with the pilot end casehardened. The two blades were made from pieces of a discarded milling cutter. This counterbore has unusually free cutting properties, and has successfully overcome trouble of any kind when used under severe conditions of service. D. A. H.

RECESSING TOOL

A recessing tool that I recently designed for performing a certain piece of work may prove of interest to readers of MACHINERY, as the same idea might be successfully employed in the construction of recessing tools for many different classes of work. This tool is used in a drill press, and collars *A* and *B*, Fig. 1, are adjusted so that the recessing operation starts when collar *B* comes into contact with the top of the work. The portion of the tool extending below collars *A* and *B* is a free fit in the hole to be recessed, and forms a bearing for cross-bar *C* that supports the recessing tool. This cross-bar has spiral gear teeth cut in it which mesh with rack teeth cut in *D*.

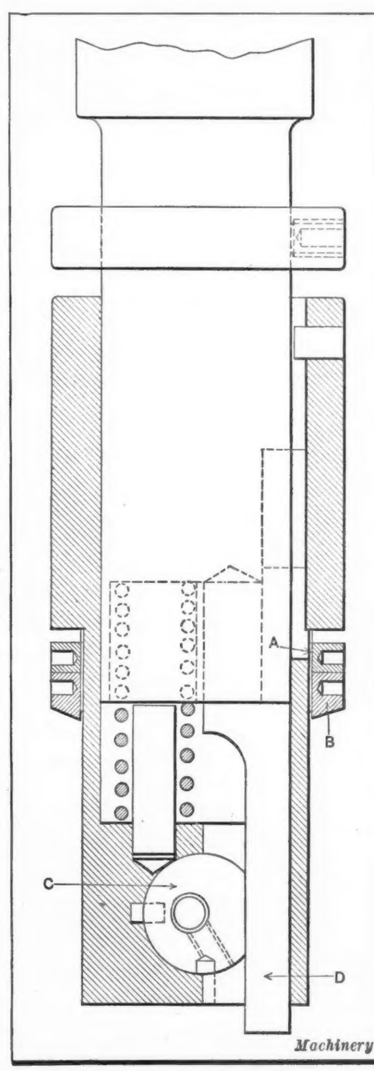


Fig. 1. Design of Efficient Recessing Tool that is used in Drill Press

In operation, the tool is entered into the hole in the work and fed down until collar *B* comes into contact with the top of the work, which retards further downward movement of the sleeve supporting bar *C*. The shank of the tool and bar *D* carried by it continue their downward movement, which results in the spiral rack teeth giving bar *C* the necessary transverse movement to bring the recessing tool into operation. At the same time, this tool is being revolved by the drill press to enable the recess to be cut. After the machining has been finished, the tool is withdrawn by raising the drill spindle, and in so doing the shank and rack *D* are raised, to provide for withdrawing bar *C* and the cutter from the recess, so that the entire tool can be lifted from the work.

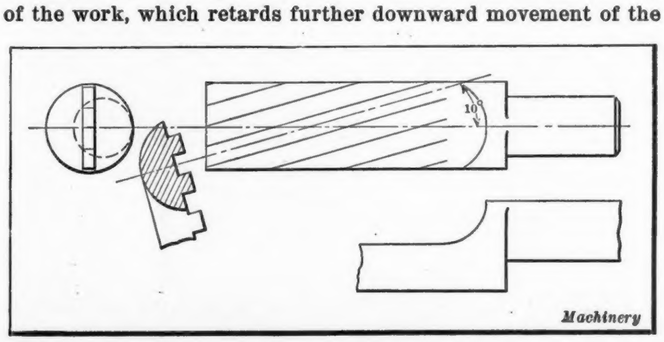
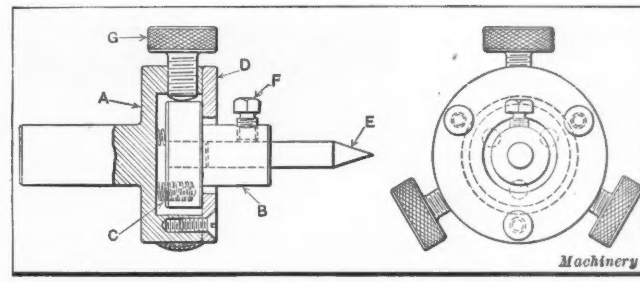


Fig. 2. Detail of Feed Bar D, showing Rack Teeth that engage with C to feed Recessing Tool

Moline, Ill. H. W. JESPERSEN

LOCATOR FOR HOLES TO BE BORED OR DRILLED



Construction of Locator for center-punching Work to be bored or drilled

Drill jigs are often laid out to scale measurement with surface gage and dividers. By using a magnifying glass, keeping the scriber points well sharpened, and exercising a moderate amount of care, lines may be placed with great accuracy. But getting even a very small center-punch mark exactly on the intersection of two scribed lines, especially on cast iron, is a difficult task, as anyone who has tried will admit. To strap a jig to a lathe faceplate, position a punch mark with a "wiggler" indicator, and counterbalance the job is a lengthy and provoking task, especially if the jig is large and of irregular shape or has holes much off center. With the aid of the tool shown, however, such work can be more accurately, easily and quickly done on a milling machine, or even on a drill press having a screw feed table.

The tool has few parts and requires no particular care in its construction. The body *A* has a shank at one end, while the other end is recessed to contain the pointer holder *B*. Holes are drilled in one end of pointer holder *B* for the three coil springs *C*, which keep it in constant contact with a retainer plate *D*. The pointer *E* is of casehardened cold-rolled steel, with a taper ground truly round to a sharp point, but not necessarily concentric with the straight part. It is held in the holder by the set-screw *F*. The pointer is set in position by means of the knurled-head fine-pitch screws *G* that bear against the enlarged end of holder *B*.

A universal chuck on the machine spindle serves to hold drills, boring tools and locator. The taper point *E* is trued up with an indicator for each hole to be located. The indicator should be of the block type, such as the Boulet, as it may then be held in place on the work or machine table by a weight. The indicator must be applied as low on the taper as possible and the machine spindle turned by hand while screws *G* are being adjusted. After the adjustments are made, the setting should be tested by running the machine a few revolutions by power before the indicator is removed. Of course, the extreme point is the only part required to run true. The line intersections must not be center-punched when this tool is

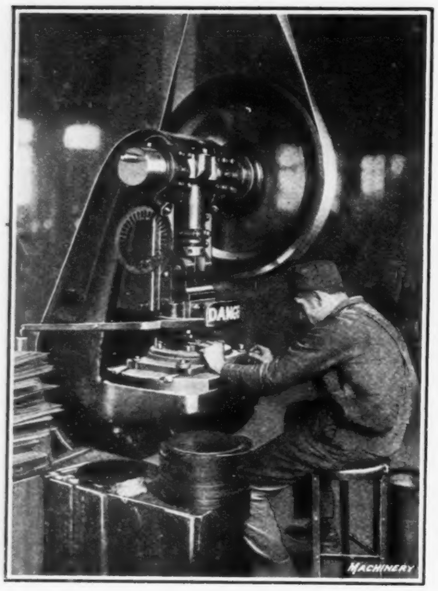


Fig. 1. Punch Press equipped with Safety Device

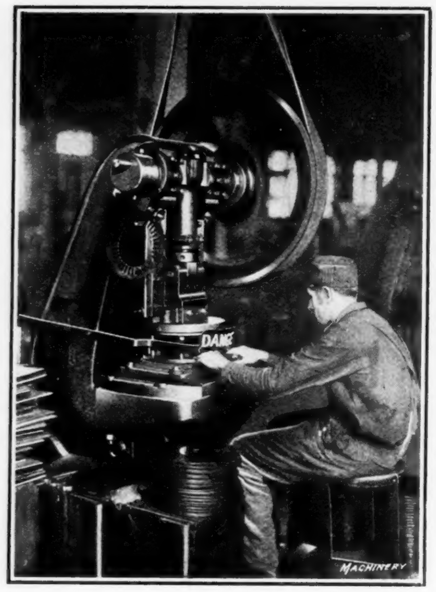


Fig. 2. Operation of Safety Guard shown in Fig. 1

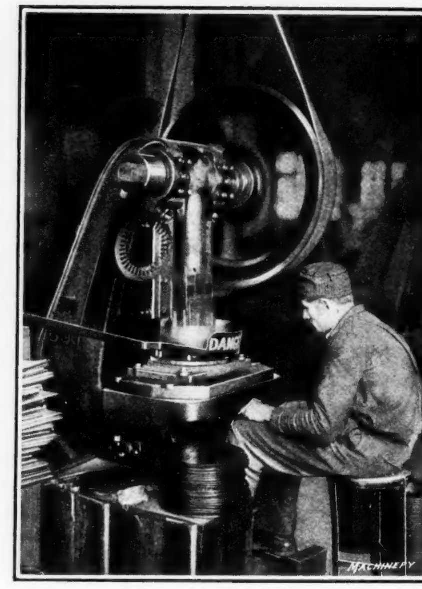


Fig. 3. Position of Guard when Punch Press is in Operation

used, as by bringing the work very near the point, the tool may be set practically on the exact intersections of the lines. With a little practice, the truing up of the pointer *E* can easily be done in from one-half to one minute.

Anderson, Ind. LEROY M. CURRY

SAFETY APPLIANCES

The accompanying illustrations show some appliances suggested in one of the many safety-first campaigns that have been made in most of the manufacturing plants and machine shops. These guards can be attached to almost any machines of the same nature. In Fig. 1 is shown a punch press used, in this instance, to make the punchings for an electric motor. This press is equipped with a safety guard that is attached direct to the foot release and drops a little before the punch, as shown in Fig. 2. In this way it prevents injury to the operator's fingers, as it strikes them if they are in a dangerous position and completely covers the opening between both parts of the press. In Fig. 3 is shown the position of the guard when the press is in operation. In Fig. 4 is shown a 200-pound drop-hammer. A foot-release drops the hammer, but the hammer cannot strike the work unless the blocks of wood are withdrawn. This can be done only by using both hands, as shown in Fig. 5.

St. Louis, Mo. J. C. GRINDELL

FIXTURE FOR FORM-MILLING FLAT CAM

The flat cam illustrated at *A* is one that would ordinarily have been handled on a profile milling machine, but owing to the large amount of work that had to be handled on these machines it was placed on a plain horizontal milling machine equipped with the fixture shown. One edge *I* of this cam was to be milled round and to form. The rounding was done by a concave cutter *E*, and the form was obtained by milling in the usual manner when the work was held in the fixture.

This fixture consists of four principal parts: a base *H*, a slide *B* upon which the work is held, a slide *C* that carries a

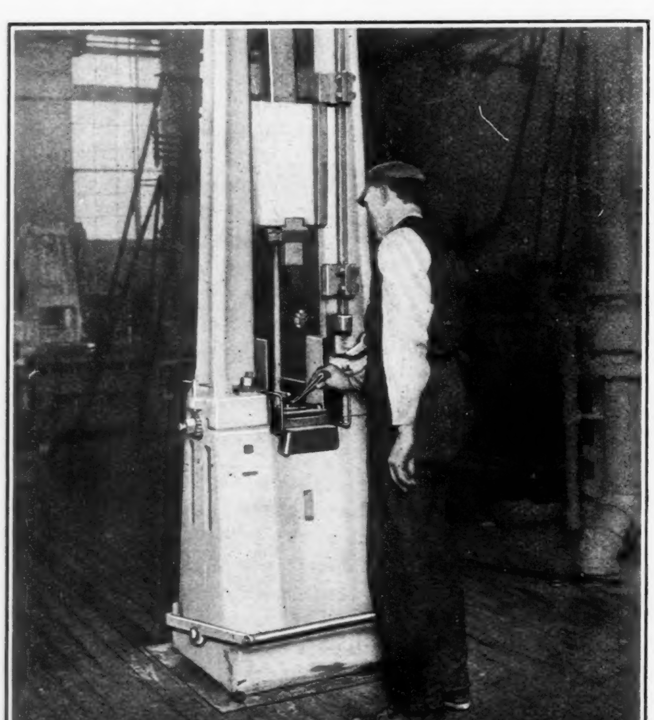


Fig. 4. Power Hammer with Safety Blocks in Position

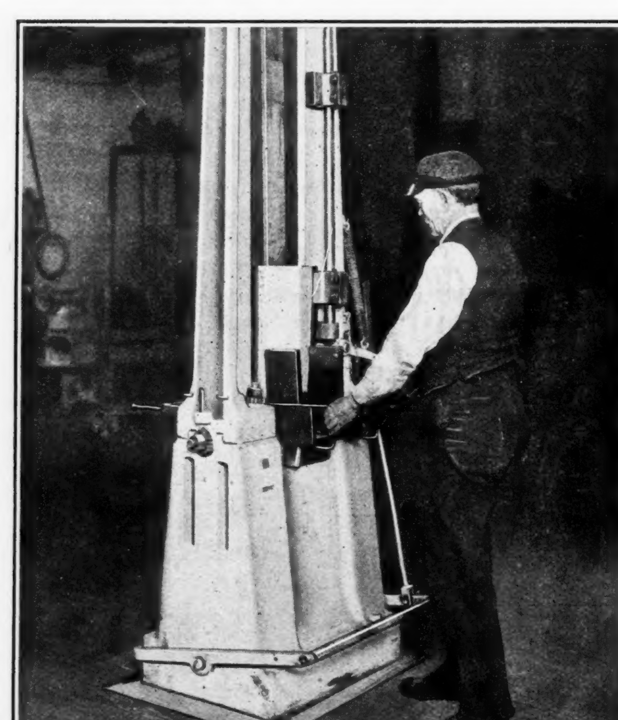
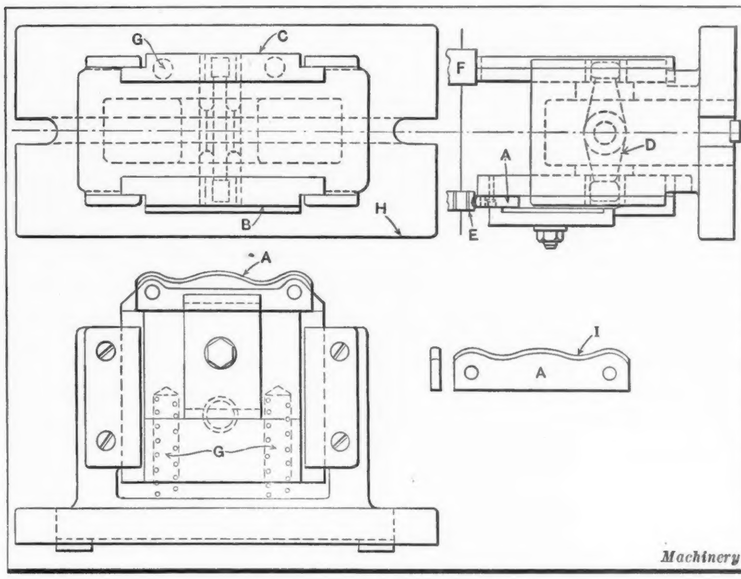


Fig. 5. Power Hammer in Operation

master cam, and a lever *D* that connects the two slides *B* and *C*. The concave cutter *E* and a ball-bearing roll *F* are mounted on an arbor, which is held in the spindle of the machine. When the cam is being milled, the roll rides along the master cam on the fixture, which is held against the roll by the springs *G*; this causes the work to be raised or lowered under the cutter by the action of lever *D*. To obtain good results with a tool of this type, the slides must be rugged and well made, as any looseness will cause chattering, and the springs that cause the master cam and slides to follow the roll on the arbor must be stiff enough to prevent the cutter from hogging into the work.

F. SERVER



Flat Cam and Fixture for milling

WHY THE SCALES DIDN'T WEIGH CORRECTLY

The lathe that wouldn't turn correctly with a weight on the floor near it, mentioned in the September number of MACHINERY, had nothing on the coal scale that wouldn't weigh a ton when the wagon was filled to overflowing. After the platform had been taken up and the adjustments and leveling checked, the only source of trouble left was the rod that ran up through the floors to the beam in the office. This was all right, the owner insisted, and he didn't want any time spent examining that, for he said no one ever went in between the floors and the rod ran through unobstructed space. However, one of the boys sneaked in there with a pocket flash lamp and found a barrel of lime resting against the rod. D. A. H.

FORGING MACHINE PARTS

In looking over working drawings one often sees the words, "Smooth-forge this piece"; but sometimes no great advantages are obtained by making certain parts from forgings. When the part is quite regular in shape and is made of machine steel, the cost of the forging greatly exceeds the cost of machining and the extra cost of the steel removed by the machinist. Although it is impossible to eliminate forgings for machine parts, careful consideration should be given the work before specifying that parts that are not of a very irregular shape should be forged before machining. Sometimes the part must be extra tough to withstand excessive strains. In such cases, it has been found cheaper to use a better grade of steel and machine the part direct than to use a forging; of course, the part must be symmetrical in form.

One case of this kind was where a large and expensive oval tapered broach used in the manufacture of production parts was forged, and after machining was sent to the hardening shop. It was heat-treated under the supervision of a good practical man and sent back to the machine-room in what might be considered good condition. After being ground to size, it was put to work, but broke under the pressure of the first production part. Upon examination, the piece was said to have been "cracked in hardening." A second broach was then made. This was machined direct from the stock, so as to get it out more quickly, as the blacksmiths were very busy and the production output was retarded for want of the piece. This broach has broached many thousand pieces and is still in good condition. Probably the steel taken from stock was more homogeneous than the forging. In large plants this plan of making parts direct from stock should not be overlooked, as one may find many cases where it is much cheaper to produce the required machine part from stock than by smooth-forging.

New Haven, Conn. ERIC LEE

LARGE COUNTERBORE FOR SPOT-FACING

The tool shown in Fig. 1 was designed by the writer for spot-facing and cutting clearance on a large steel casting and was used on a horizontal boring mill. It is mounted on a heavy boring-bar and is clamped by means of two set-screws on the hub. The cutter extending beyond the outside diameter of the body and one just like it in the opposite block (not shown) cut a clearance on a projecting part of the casting. These have the form shown at *A*, Fig. 2; the form of the thirty-four other cutters is shown at *B*. When the cut reaches the face of the work the feeding must be slow and the cutting steady to a depth of from 1/8 to 3/8 inch, according to the variations in the casting. These variations, which are common evils in steel castings, were the cause of the operation, the object of which was to

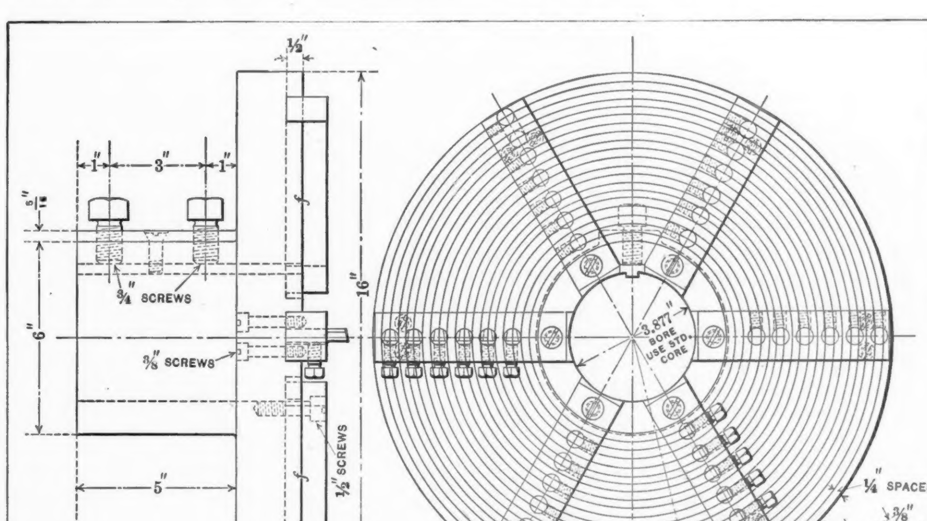


Fig. 1. Counterbore for spot-facing

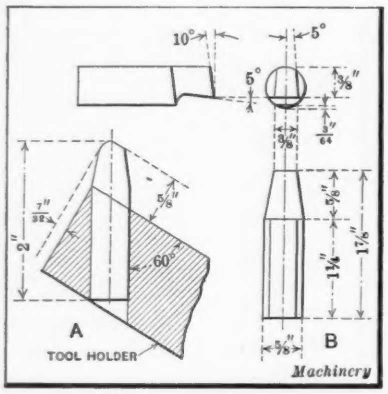


Fig. 2. Forms of Tools used in Counterbore

give proper clearance to a gear.

The cutters were set in such relation to each other on the face of the body that the entire surface was covered with a generous allowance of lap to insure that no ridges were left on the finished surface. A fine finish was not necessary, and a saving of 75 per cent of the time required for this operation when using a single-point tool was effected. The upkeep of this tool was not excessive, the cutters being made of high-speed steel and of such shape that they could be ground the same as a milling cutter, all being mounted in rows with their cutting faces in a straight line. The bearing face proper was finished in the ordinary manner with a sweep tool to an exact dimension. The only remarkable thing about this tool is the large surface covered in an unusual manner.

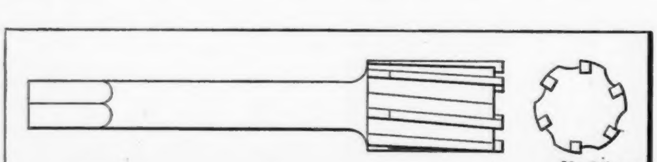
Columbus, Ohio. OTTO R. WINTER

HIGH-SPEED CHUCKING REAMER OR CORE DRILL

Before the outbreak of the European war, few shops thought of making their own core drills. However, we found not long ago that it would take six weeks to have a four-fluted carbon-steel twist drill made to be used in a jig, so we decided to make it ourselves. The one made is shown in the accompanying illustration. It was used for machining ninety-eight holes, 1 15/16 inch in diameter and about 4 inches deep, in split boxes. There were two to each casting, and the distance between centers had to be very accurate and all the castings interchangeable.

The body of the drill was made from machine steel; the blades were made of "Rex AA," the cutting ends being located to a high heat and hardened in water. The blades were 2 inches long and projected 5/16 inch beyond the body. They were fitted with a disk grinder in 5/16-inch slots inclined at an angle of 10 degrees in the body. The front edge of the slot was radial on the front end of the body. The diameter of the cutting end of the drill was 0.002 inch larger than the other end. This drill worked so well that the boxes were reamed, with a 1/8-inch split between the box and the cap, in less than one-half the time that would have been required had a carbon core drill been used, and the cost was just about the same. As a result, another drill of this design but of a different size has since been made, and we will probably make all our large-size rose chucking reamers, for in this way properly tempered high-speed chucking reamers will be obtained for about the price of carbon reamers.

One twist-drill company had almost the right idea when it made a chucking reamer with the high-speed blade welded in, but the tool had three faults: The blade was backed off, so that it cut sidewise and followed untrue holes; the blades were too thin—they would not have had enough wearing surface had they not been backed off; and the blades were set parallel with the body, thus giving no rake for cutting. Milling cutters that have no rake are scrapers, not cutters, and end-mills made with spiral grooves give the end cutting edges a negative rake that is intolerable. But these homemade reamers make reasonably true holes out of rough bored holes, and do it rapidly. Distillate is used to lubricate them.



Reamer or Core Drill with Inserted High-speed Steel Blades

Los Angeles, Cal. S. B. WELCOME

PATCHING CONCRETE FLOORS

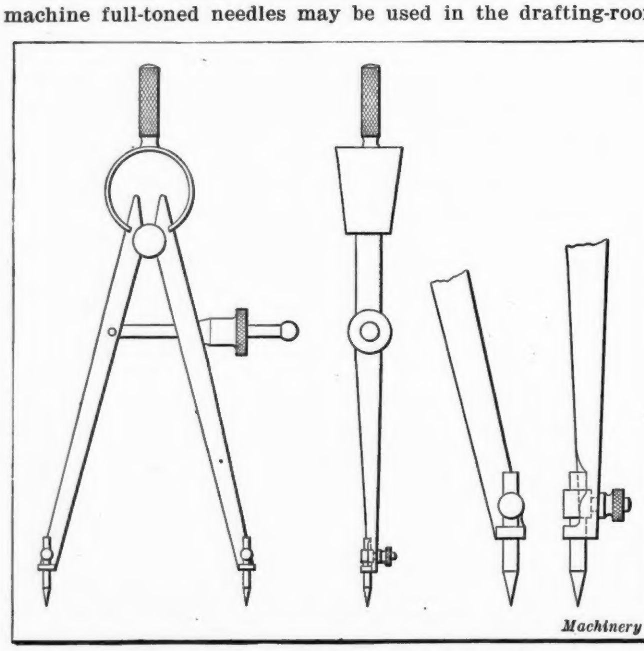
The item "Patching Concrete Floors" in the August number of MACHINERY seems to have created an entirely erroneous impression among some readers, so much so that the chief engineer, Ernest McCullough, of the Portland Cement Association has called it to the attention of W. P. Anderson, president of the Ferro Concrete Construction Co., whose experience was quoted. Mr. Anderson did not imply that deep holes or large areas could be successfully patched by the use of a mastic material, but somehow this impression seems to have been created. Inasmuch as this method of patching concrete floors is of considerable value when rightly used, we would very much appreciate your publishing a correction somewhat as follows:

> In "Patching Concrete Floors," recently published, it should have been stated that the use of a mixture of asbestos fiber and rubber gum is not applicable to the repair of deep holes or large areas. Such patches are quickly made and give excellent results when confined to patches about 1/8 inch thick and where truck loads do not exceed 1 1/2 ton, but when used on deep holes or on large areas they will not stand up and give satisfactory service.

Boston, Mass. WALTER B. SNOW AND STAFF

VICTOR TALKING MACHINE NEEDLES USED AS DIVIDER POINTS

The accompanying illustration shows how Victor talking machine full-toned needles may be used in the drafting-room and the machine shop. They make good divider points, and are economical to use, as the cost is only five cents a hundred and they do not require grinding.

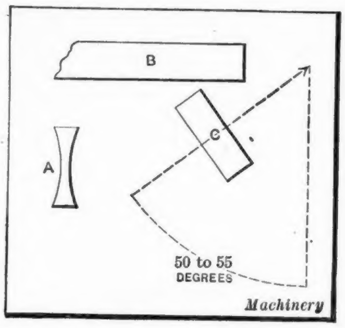


Dividers with Talking Machine Needles for Points

Cleveland, Ohio. FRED C. LATIMER

PIVOT DRILLS

One day, in about the middle of my apprenticeship—and I am not nearly old enough to be a Civil War veteran—the "boss" brought into the shop and exhibited as a great curiosity a twist drill, the first any of us had seen. Not till many years later did I see one in use. At that time chucking drills, "hog noses" and a few other drills for special uses were made in a lathe, but the ordinary everyday tool was the plain hand-forged flat drill. In shops too small to employ a blacksmith, every man made his own tools, unless he could shift the job on to the "cub." We should have been surprised to learn that flat drills were ever made in any other way than by forging out the end of a piece of round stock, shap-



Making Pivot Drills

ing it with hardy and file, then hardening and tempering.

A few years later, however, I was employed in a trade where the process was entirely different, the steel being hardened and tempered and then brought to size and shape by grinding in the lathe. These were the small tools, from 0.005 to perhaps 0.020 inch, which the watchmaker calls "pivot" drills, and the forging method was obviously inapplicable for their manufacture. Nowadays these drills are usually bought ready made, but some of the older watchmakers prefer to make their own, and workmen who are far from tool stores have to make a few, now and then.

The raw material is drill rod, Nos. 66 or 67 being often chosen because it fits the No. 8 chuck which is 0.8 millimeter in diameter. This rod is cut into inch lengths, which are hardened and then "let down" by holding one end in the flame of an alcohol lamp until the other end, which is to be the working part of the drill, becomes the proper straw color. The blank is then put into a split chuck in the lathe and from 1/8 to 1/4 inch of the end is reduced to the diameter of the finished drill by a wheel carried by the pivot polisher, a near relative of the machinist's toolpost grinder. Theoretically, it is considered best practice to set the wheel spindle at an angle of about one-half degree to the lathe axis, so that the drill will taper back, or be a fraction of a thousandth inch larger at its tip, but this hair-splitting refinement is by no means universally adopted. Next, the lathe spindle is locked by the sixty-hole index plate on the cone pulley, and the sides of the drill are ground, using the periphery of the wheel which gives the shape shown at *A*. Now the spindle is turned forward until the drill lips are horizontal and is then indexed three holes (or 18 degrees) farther, after which the wheel is passed over the lips as shown in the illustration, where *B* is the drill blank and *C* is the grinding wheel. This completes the job, and though the process may seem long from the description, a dozen drills can be made very quickly when the lathe is once set up. Each operation, of course, is performed on the whole dozen before the set-up is changed.

The continued use of the flat drill is not, as some people think, the result of hide-bound conservatism. In the sizes below No. 80, one has no choice, as the manufacture of twist drills of such minute dimensions is not an attractive commercial proposition, and in larger diameters the flat form is superior for certain classes of work. It manifests no tendency to draw in, and many good workmen believe that in lathe work on the softer metals it makes a smoother, straighter hole than its modern competitor.

New London, N. H. GUY H. GARDNER

CASTING BRASS NUTS ON FEED-SCREWS

In the October number of MACHINERY T. M. complained of the unsatisfactory service given by the brass nuts on the cross-feed screws of the cutting-off lathe, and asked for information concerning the casting of the nuts on the screws. While the writer has not done exactly the work mentioned by T. M., he has had considerable experience along that line, and would say that probably the reason the brass feed-screw nuts are not giving satisfaction is that yellow stick brass is used. Besides, this kind of casting is often poured from the metal in the bottom of the ladles or from metal which is unfit for other work. In addition, the molds are so simple that they are made by the cheapest help or by apprentice boys. Out of 150 bars of this material that the writer examined, only about 10 per cent was fit for use where hard service was required.

An analysis of yellow brass generally shows that it is 70 per cent copper and 30 per cent zinc; the slight variations are usually due to impurities such as a small amount of lead, tin or iron. This metal has a total strength of from 28 to 32 tons per square inch and an elongation of from 22 to 28 per cent; its scleroscope hardness is about 20. An alloy containing from 82 to 86 per cent copper, 10 to 14 per cent tin, 1 to 3 1/2 per cent zinc, and a small percentage of lead would give better results. The physical properties will be about the same, but the elongation will be slightly less, indicating greater hardness. A good dense metal is produced by melting at a temperature no hotter than necessary, taking care to prevent oxidation by covering the molten metal with charcoal. If zinc is used, it should be melted in a separate crucible, as it oxidizes readily and there is a great difference between its melting point and that of copper. The tin can be added to the copper just before it is to be poured, and the molten zinc can be added immediately afterward.

Casting a nut on a feed-screw can be done, but it would require experimenting, because few foundries are familiar with this class of work. A better way would be to cast the stick metal in a chill. All brasses and bronzes give off a certain amount of gas, so the sooner these metals are solidified the smaller are the areas containing the gas or gas holes. If these metals are kept molten a long time, the gases will find their way out; but as they are generally cast before this is possible, the gases are entrapped and holes result. An examination will show that chilled cast metal has a finer and closer grain than that cast in other molds, so that chilling will produce better results than ordinary methods.

In casting brass nuts on feed-screws, care will have to be taken to support the screw so as not to crush the mold. If the outside diameter of the nut is not large, thus giving a small area of metal, when the mold is poured the interior will solidify and the nut will shrink onto the screw. If the nut has a large cross-section, the metal which is solidified will be heated and a looser fit will result. In all cases, the nut should be removed from the screw as soon as possible. The shrinkage of brass is greater than that of iron or steel. It might be well to use a screw a few thousandths inch larger than the one on which the nut is to be used, so that when the nut is cold it will be near the correct size and have sufficient clearance. The threads will shrink on the sides, giving plenty of clearance, but the nut will bind on the outside and root diameter. If there is not sufficient clearance, a light cut may be taken, but this will remove some of the chilled metal.

When a green-sand mold is used, if the feed-screw is heated the mold is likely to crumble unless the metal is cast immediately. This causes trouble in handling in the foundry, because the work is then a special and not a production job. A better way is to run the metal through the mold. By this plan the screw is heated, and so dense a metal will not be produced as when it is cast on a cold screw. But this may be necessary to produce a sound casting, due to the small area of the thread. When the shaft or screw becomes cold, the nut will be easily separated on account of the shrinkage of the shaft. A dry-sand or skin-dried mold can be used if it is desired to use a heated screw. Besides producing a denser casting, this will do away with all danger of the screw crushing the mold.

A screw may be coated with seal oil into which has been stirred foundry facing (graphite), but the oil must be thinly and evenly applied. Plain graphite can be rubbed on, but it is not so efficient. Care must be taken to see that there is no rust or moisture on the screws, or gas holes will result. When the screw is coated with oil, the heat decomposes the oil, which gives off a film of gas; this makes removal of the nut from the screw quite easy.

However, results would have to be very discouraging before the writer would attempt to cast the nuts on the screws, because it is an impractical way at best. If the correct mixture is used, he thinks that casting a bushing in a chill with a straight metal core of approximately the right diameter and machining afterward would be preferable. Even in sand-cast material, a core should be used; a closer-grained metal will then result. The metal should be poured from the bottom of the mold, and a reasonable amount from the top of the stick should be scraped, as it will contain all the impurities.

G. C. R.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

GRINDING CHILLED CAR WHEELS

H. C. V.—I have about twenty chilled cast-iron car wheels with flat spots to be repaired. I know that they can be ground, but would like to know if they could not be turned in a lathe.

A.—It is not commercially feasible to turn chilled cast-iron car wheels in a lathe, and it is seldom, if ever, done. Powerful lathes of special design are required for turning chilled iron, and no ordinary engine lathe could be used for turning chilled wheels. The flat spots, if not too deep, may be removed by grinding in a car wheel grinding machine.

ALLOWANCES FOR FITTING PARTS FOR BRAZING

W. G. Co.—Will you advise us what allowance should be made in the fitting of a steering wheel shaft in a socket of the worm when it is to be pinned and brazed? The diameter of the socket is one inch.

A.—The socket should be bored or the shaft should be turned to make a light drive fit when preparing for pinning and brazing the parts together. It is generally conceded by braziers that two parts to be brazed together cannot be fitted too closely. When the parts are heated and spelter is applied, the melted spelter will penetrate into the interstices of the closest fitted joint, and the brazing will be much stronger under such conditions than if the joint is loosely fitted and the spaces filled with spelter. In general, then, in fitting parts to be brazed, fit them closely and use as little spelter as possible. Wide open spaces are not favorable to sound brazing, and should always be avoided.

HIGH-SPEED STEEL

H. S. H.—What is the meaning of the term "high-speed" as applied to steel? I have believed that it referred to the cutting quality only and not to the composition of the steel in question. I know that most of the present high-speed steels contain a certain percentage of tungsten, but understand that tungsten is not absolutely necessary. Must a high-speed steel conform closely to a given chemical analysis, and is tungsten a necessary element?

A.—A high-speed steel is not necessarily one conforming to any given analysis, nor is tungsten a necessary element. Most high-speed steels contain tungsten, but other elements, such as molybdenum, confer the red-hardness characteristic. We would define a high-speed steel as one that cuts metals at a much higher rate of speed than ordinary carbon tool steel. A high-speed steel should continue to cut when the point of the tool becomes heated to a dull red temperature because of the red-hardness characteristic conferred upon it by tungsten, molybdenum or other alloys.

LOGARITHM OF 0

B. D. K.—What is the logarithm of 0? In one set of tables, I notice a dash is printed; in another set, it is recorded as 0; in MACHINERY'S HANDBOOK, it is printed inf. neg.

A.—The logarithm of 0 is designated by $-\infty$, read minus infinity. That this is correct will be readily apparent from the theory of exponents. If n represents any number greater than 1, any positive number may be represented by n^a, the value of a being different for different numbers. Here a is called the logarithm of the number to the base n, and if a is positive, n^a is greater than 1; but if a is negative, $n^{-a} = \frac{1}{n^a} =$ some number less than 1, but greater than 0, or, in other words, a decimal fraction. When a becomes infinitely great, the value of $\frac{1}{n^a} = \frac{1}{n^\infty} = n^{-\infty}$ becomes infinitely small; that is, it becomes 0. Consequently, $\log 0 = -\infty$, which is the value printed in MACHINERY'S HANDBOOK, the abbreviation inf. neg. standing for infinite negative. J. J.

MACHINING MONEL METAL

M. A. M.—Can you give me information regarding the working of monel metal in the machine shop, especially with respect to drilling and shearing in dies. I would also like to know the cutting speed, angle of rake and clearance of cutting tools, and the best lubricant to use when drilling or turning.

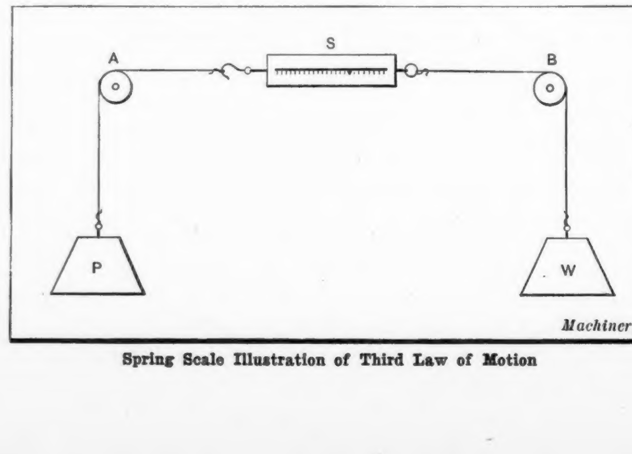
Answered by the International Nickel Co., Bayonne, N. J.

A.—Monel metal machines with a long tough chip, resembling copper in many respects, but requiring more power. Rolled or drawn monel and mild steel require practically the same power for machining. Cast monel requires somewhat more power to machine than the rolled metal. It has a tensile strength of about 65,000 pounds per square inch, and rolled or drawn monel has about 80,000 to 100,000 pounds per square inch tensile strength. Our usual practice in machining is to cut the metal dry at a speed of about forty feet per minute. We have taken a cut 1/4 by 1/20 inch feed at a speed of 150 feet per minute forty inches long without the tools breaking down. In this case we used a cooling compound. On our cutting-off machine we use a mixture of lard oil, borax and aquadag for cooling with good results. On our milling machines we use a mixture of "Oakite" with satisfaction. High-speed steel cutting tools are essential in machining monel. Our experience has been limited in drilling monel, but we know that some difficulties are presented, as the metal forms a tough chip like copper and tends to stick to the drill. It is also harder and requires more power to drill, being comparable to high carbon steel. We consider that "Oakite" would be a good lubricant for drilling and recommend that high-speed steel drills be used.

SPRING SCALE PROBLEM

J. E. F.—"A" claims that if he holds a spring scale in his hands and makes it indicate 50 pounds, he has exerted 100 pounds of energy; that is, he must resist 50 pounds with one hand while pulling 50 pounds with the other. "B" claims that the pull and resistance are equally divided in each hand; and, in order to make the scale register 50 pounds, he must exert 25 pounds pressure in each hand. Which is right and why?

A.—According to the third law of motion, action and reaction are equal and opposite. The force indicated by the spring is the action, and if this be 50 pounds, the reaction must also be 50 pounds; hence, each hand exerts a force of 50 pounds. That this statement is correct may easily be shown by means of a simple experiment. Referring to the illustration, let S be a spring scale and A and B two pulleys, the centers of which are the same distance from the floor level. Then, in order that the scale may not move, the weight P must be equal to the weight W; but the pull registered by the scale will be that of only one of the loads. Here P represents the left hand and W the right hand. J. J.



Spring Scale Illustration of Third Law of Motion

NUMBER OF BALLS THAT CAN BE PLACED IN A CYLINDER

M. F. W.—Referring to the August number, page 1084, suppose the box had been a cylinder instead of a cube; how many balls of equal and maximum size could be placed in the cylinder around the large ball?

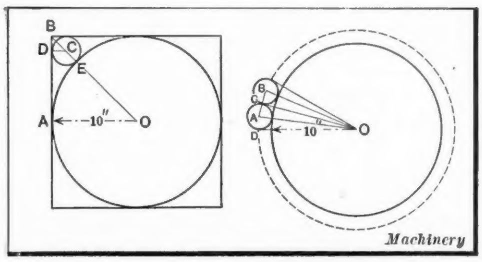


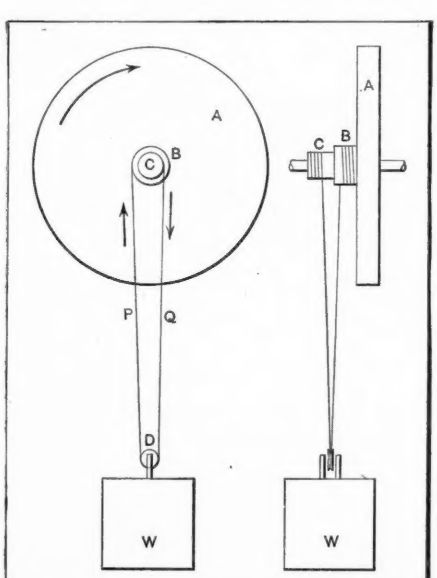
Diagram for calculating Number of Balls that can be placed in a Cylinder around a Large Ball

A. — The figure at the left of the illustration represents a vertical section through the centers of the large ball and one of the small balls. $OB = 10\sqrt{2}$, and $BE = 10\sqrt{2} - 10$. Letting r = radius of small ball $= CD$, $BC = r\sqrt{2}$. Hence, $r\sqrt{2} + r = 10\sqrt{2} - 10 = BE$; or, $r = \frac{10\sqrt{2} - 10}{\sqrt{2} + 1} = 1.715729$ inch. The figure at the right of the illustration represents a top view with the top of the cylinder removed. Assuming that the balls touch, they will lie so that their centers will be in a circle whose radius is $10 + r$, and BOC will be a right triangle, right-angled at C. Sin $BOC = \frac{r}{10 + r} = \frac{\sqrt{2} - 1}{2\sqrt{2}}$, after substituting the value of r as found above. Log sin $BOC = \bar{1}.1656793$, from which $BOC = 8$ degrees, 25 minutes, 15.81 seconds. This angle is evidently equal to half the angle $BOA = COD$. Hence, the number of balls in the top layer is equal to 360 degrees $\div 2 \times 8$ degrees, 25 minutes, 15.81 seconds $= 180 \div 8.42106 = 21.37 +$, since 25 minutes, 15.81 seconds $= 0.42106$ degree. The number of balls is therefore 21 on top and 21 on the bottom, or 42 in all. J. J.

THE CHINESE WINDLASS

F. H. E.—I enclose a sketch of a hoisting device. Suppose that the diameter of the wheel *A* is 42 inches, and that the diameters of the drums *B* and *C* are 10 inches and 8½ inches, respectively; how large a weight can be lifted if a force of 40 pounds is applied at the circumference of the wheel? What is this apparatus called?

A.—The apparatus is called a Chinese windlass; some writers on mechanics call it a compound wheel and axle. The principle of virtual velocities (see MACHINERY for June, page 897) applies here as in the case of any other machine, *i. e.*, the weight multiplied by the distance through which it moves equals the power (force) multiplied by the distance through which it moves. Let R, r, and r' be the radii of A, B, and C, respectively, and suppose A to make one revolution; then the distance moved by the power will be $2\pi R$. At the same time, B and C make one revolution also. As the part P of the rope winds on drum B an amount equal to $2\pi r$ and rope Q winds off drum C an amount equal to $2\pi r'$, the rope is shortened an amount equal to $2\pi r - 2\pi r' = 2\pi(r - r')$. The weight W is raised only one-half this distance, however, since it is divided equally between P and Q, D being a movable pulley. Hence, the distance W moves is $2\pi(r - r') \div 2 = \pi(r - r')$. Therefore, $P \times 2\pi R = \pi(r - r') \times W$; from which $W = \frac{2PR}{r - r'}$. Substituting the values given in this formula, $W = \frac{2 \times 40 \times 21}{5 - 4\frac{1}{4}} =$ 2240 pounds. A mechanism of this kind ought to have an efficiency of at least 0.90; whence, the weight lifted ought to be at least $2240 \times 0.90 = 2016$ pounds. J. J.



Chinese Windlass, or Compound Wheel and Axle

DISCHARGE OF AIR INTO THE ATMOSPHERE

W. M.—Please let me know a formula that will give the cubic feet of free air that will flow through an orifice of known size into the atmosphere, the gage pressure in the tank being anywhere from 5 to 50 pounds per square inch.

A.—Let T = absolute temperature of air in tank in degrees F. $= 460 +$ temperature indicated by thermometer; let p = absolute pressure in tank = gage pressure + pressure indicated by barometer in pounds per square inch; p_1 = pressure of atmosphere as indicated by barometer; and V = velocity of flow through orifice in feet per second. Then the theoretical velocity of discharge is:

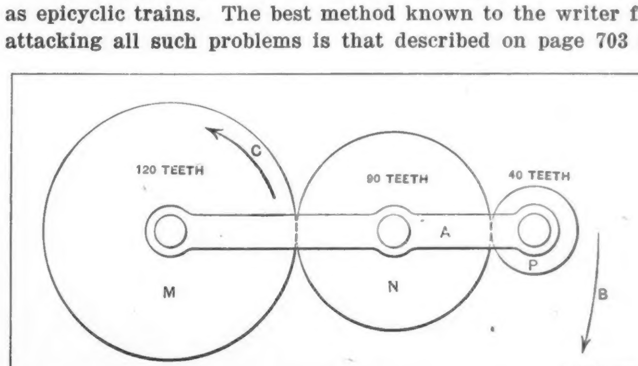
$$V = 108.67\sqrt{T\left[1 - \left(\frac{p_1}{p}\right)^{0.2907}\right]}$$

If you have no barometer, you may assume that $p_1 = 14.7$ and p = gage pressure + 14.7. The actual velocity will not be so great as calculated by the formula, because it will be affected by the size and shape of the orifice, practically the same conditions obtaining as in the case of the discharge of water. If the discharge is through a short tube the length of which is two or three times the diameter of the orifice, the actual velocity of discharge may be taken as $0.98V$. It is also assumed that the pressure in the tank remains constant. Assuming that the pressure in the tank is 10 pounds, gage; that the temperature is 70 degrees, and that the diameter of the orifice is 1½ inch, $p = 10 + 14.7 = 24.7$, $p_1 = 14.7$, $T = 460 + 70 = 530$; then, $\left(\frac{14.7}{24.7}\right)^{0.2907} = 0.85996$, and $1 - 0.85996 = 0.14004$; whence, $V = 108.67\sqrt{530 \times 0.14004} = 936.2$ feet per second. The discharge is at the rate of $\frac{0.7854 \times 1.5^2}{144} \times 936.2 =$ 9.126 cubic feet per second = 547.56 cubic feet per minute. The actual discharge may be taken as $0.98 \times 547.56 = 536.61$, say 537 cubic feet per minute. J. J.

A PROBLEM IN EPICYCLIC GEARING

A. M. S.—Referring to the diagram, *M* has 120 teeth, *N* has 90 teeth, and *P* has 40 teeth. If the arm *A* makes fifty revolutions per minute in the direction indicated by the arrow *B*, and gear *M* makes thirty-six revolutions per minute in the direction indicated by the arrow *C*, how many revolutions per minute will gears *N* and *P* make and in what direction?

A.—Gearing of this kind belongs to the general class known as epicyclic trains. The best method known to the writer for attacking all such problems is that described on page 703 of



Epicyclic Gearing

MACHINERY'S HANDBOOK. Applying this method to the present case, suppose all the gears are locked and that the whole mechanism is turned around in the direction indicated by the arrow B fifty times; then imagine the gears to be released and the arm A stationary, and that gear M makes thirty-six turns in the direction indicated by the arrow C. Calling rotation in the direction of B positive or $+$, and that in the direction of C negative or $-$, the following results are obtained:

	M	N	P	A
Wheels locked	$+50$	$+50$	$+50$	$+50$
Arm stationary	-36	$+\dfrac{120}{90}\times 36$	$-\dfrac{120}{40}\times 36$	0
	$+14$	$+98$	-58	$+50$

It will be seen that gear N makes 98 revolutions per minute in the direction of arrow B, while gear P makes 58 revolutions per minute in the direction of arrow C. Gear N is an idler and so has no influence on the motion of P, except to change its direction of turning; the number of revolutions P makes is determined solely by gear M and the rotation of the arm A. When the arm A is stationary, the gears act as in an ordinary train.

J. J.

SOLVING EQUATIONS FOR SPIRAL GEARING BY TRIAL

H. A. T.—I have met with some difficulties in trying to solve the equation given on page 674 of MACHINERY'S HANDBOOK:

$$R \sec \alpha + \operatorname{cosec} \alpha = \frac{2CP_n}{n}$$

Would you kindly indicate how equations of this kind are solved by trial?

A.—Equations of the form given above are solved by trial by selecting an angle assumed to be approximately correct, and inserting the secant and cosecant of this angle in the equation, adding the values thus obtained, and comparing the sum with the known value to the right of the equals sign in the equation. An example will show this more clearly. Using the problem given on page 675 of MACHINERY'S HANDBOOK, as an example, $R = 3$; $C = 10$; $P_n = 8$; $n = 28$.

Hence, the whole expression

$$\frac{2CP_n}{n} = \frac{2 \times 10 \times 8}{28} = 5.714,$$

from which it follows that:

$$R \sec \alpha + \operatorname{cosec} \alpha = 5.714.$$

In the problem given, the approximate spiral angle required is 45 degrees. The spiral gears, however, would not meet all the conditions given in the problem, if the angle could not be slightly modified. In order to determine whether the angle should be greater or smaller than 45 degrees, insert the values of the secant and cosecant of 45 degrees in the formula. The secant of 45 degrees is 1.4142, and the cosecant, 1.4142. Then,

$$3 \times 1.4142 + 1.4142 = 5.6568.$$

The value 5.6568 is too small, as it is less than 5.714, which is the required value. Hence, try 46 degrees. The secant of 46 degrees is 1.4395, and the cosecant, 1.3902. Then,

$$3 \times 1.4395 + 1.3902 = 5.7087.$$

Apparently an angle of 46 degrees is too small. Proceed, therefore, to try an angle of 46 degrees, 30 minutes. This angle will be found too great. Similarly 46 degrees, 15 minutes, if tried, will be found too great, and by repeated trials it will finally be found that an angle of 46 degrees, 6 minutes, the secant of which is 1.4422, and the cosecant, 1.3878, meets the requirements. Then,

$$3 \times 1.4422 + 1.3878 = 5.7144,$$

which is as close to the required value as necessary.

In general, when an equation must be solved by the trial and error method, all the known quantities may be written on the right-hand side of the equals sign, and all the unknown quantities on the left-hand side. A value is assumed for the unknown quantity. This value is substituted in the equation, and all the values thus obtained on the left-hand side are added. In general, if the result is greater than the known values on the right-hand side, the assumed value of the unknown quantity is too great. If the result obtained is smaller than the sum of the known values, the assumed value for the unknown quantity is too small. By thus adjusting the value of the unknown quantity until the left-hand member of the equation with the assumed value of the unknown quantity will just equal the known quantities on the right-hand side of the equals sign, the correct value of the unknown quantity may be determined.

MOMENT OF INERTIA OF A RECTANGLE

S. W.—Will you please explain how $\dfrac{bd^3}{12}$ is equal to the moment of inertia of a rectangle?

A.—Referring to the illustration, let $MNPQ$ be a rectangle with a breadth b and a depth (altitude) d, and suppose the rectangle to turn, or tend to turn, about $X'X$ as an axis, $X'X$ passing through the center of gravity. By definition, the moment of inertia I is the sum of the products obtained by multiplying each elementary area by the square of its distance from the axis. Let p be a differential area—a square the sides of which are dx and dy, the coordinates of the center being x and y; then, by the definition, $I = \displaystyle\int_{-\frac{d}{2}}^{\frac{d}{2}} \int_0^b y^2 dy dx = \frac{bd^3}{12}$. Weisbach gives a demonstration without the use of the calculus, substantially as follows: Let AB be a narrow strip cut off by two vertical lines; draw two horizontal lines cutting off from the strip the small rectangle C, the center of which is at a distance z from $X'X$. Dividing the entire strip in this manner,

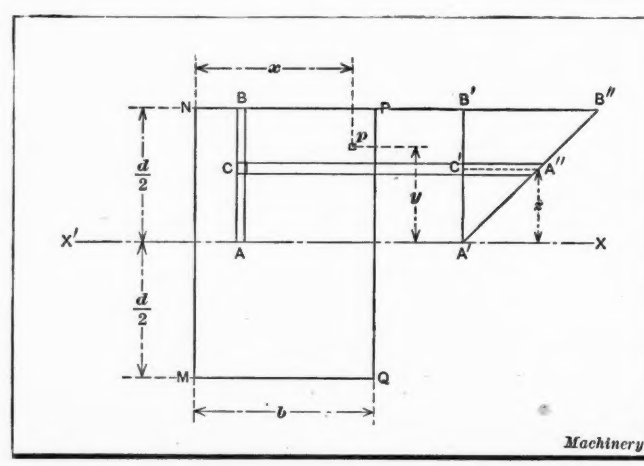


Diagram showing how Moment of Inertia of Rectangle is found

the moment of inertia of the strip is $I = a_1z_1^2 + a_2z_2^2 + a_3z_3^2 +$ etc. $= a_1z_1 \times z_1 + a_2z_2 \times z_2 + a_3z_3 \times z_3 +$ etc., in which a_1, a_2, a_3, etc., are the areas of the small rectangles and z_1, z_2, z_3, etc., are the distances of their centers from $X'X$. Produce NP to B'', draw $A'B'$ perpendicular to $X'X$, lay off $B'B'' = A'B' = AB$, and draw $A'B''$; then $A''C' = AC = z$. The product az may be regarded as the volume of a prism with the base a and the altitude $C'A'' = z$; and the moment of the prism with respect to $X'X$ is $az \times z$. The sum of all these small prisms is a triangular prism, the base of which is $A'B'B''$ and the altitude is the width of the strip $AB = b'$. The volume of this prism is $1/2b' \times A'B' \times B'B'' = 1/2b' \left(\dfrac{d}{2}\right)^2 = 1/8b'd^2$. The distance of the center of gravity from $X'X = 2/3A'B' = 2/3 \times 1/2d = 1/3d$. The moment of this volume is $1/8b'd^2 \times 1/3d = \dfrac{b'd^3}{24}$. Since this last expression is equal to the expression for I that was obtained above, the moment of inertia of the strip is $\dfrac{b'd^3}{24}$. Since the sum of the strips is one-half the area of the rectangle, the moment of inertia for one-half the rectangle is $I = \dfrac{bd^3}{24}$, and for the whole rectangle, $I = 2 \times \dfrac{bd^3}{24} = \dfrac{bd^3}{12}$.

J. J.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

ANDERSON VERTICAL TAPPING MACHINE

In working out the design of a vertical tapping machine which has recently been placed on the market by the Anderson Die Machine Co., 590 Water St., Bridgeport, Conn., provision has been made for varying the cutting speed without affecting the time per operation, *i. e.*, to have the reverse speed compensate for a slow cutting speed, and to apply an efficient motor drive in such a manner that practically the full amount of power is transmitted to the tap. This high driving efficiency is obtained by direct connection between the motor and spindle and by the use of S.K.F. ball bearings, the combination being such that it is possible to run the machine on an electric lighting service wire without undue disturbance.

The spindle is made of high-carbon steel, turned and ground to size, and S.K.F. radial ball bearings are used at both the top and bottom. In each case the inner ball race, in which the spindle moves endwise, has been increased in length by forcing into it a sleeve 1½ inch long, which is made from high-carbon steel and accurately fitted to the spindle. Spindle frictions have been designed to secure good results, and owing to the spherically faced disk on which these operate, tendency to slip has been eliminated. The face of the friction driving disk is spherical, and this disk is mounted on the armature shaft of the motor, thus eliminating the use of intermediate transmission mechanism. A spring at the upper end of the spindle can be adjusted to counterbalance the spindle weight, and this spring is enclosed to eliminate chance of accidents. The motor is of standard design, having two special brackets or lugs for attachment to the machine, so that any specified motor may be employed, provided it does not exceed 6 inches in diameter. This allows the purchaser to make his own selection.

Fig. 1. Anderson Vertical Tapping Machine on which Decrease in Forward Speed is compensated for by increasing Reverse Speed to maintain Constant Rate of Production

A circular work table is provided which is 7 inches in diameter and has a movement of 1¾ inch on two way-rods, spaced far enough apart to insure rigidity and give an easy movement. Adjustment of 3 inches is provided for the way-rods and table, giving ample space between the chuck and table for a fixture and lugs. A spring under the table can be adjusted to counterbalance the weight, thus making movement to and from the tap very sensitive, which is a valuable feature where small taps are used. A foot-treadle is provided for operating the table, and this can be easily removed by simply loosening one screw. The connection from the floor to the machine is adjustable, and is provided with a safety spring so that the lead of the tap cannot be disturbed by sudden application of pressure on the treadle.

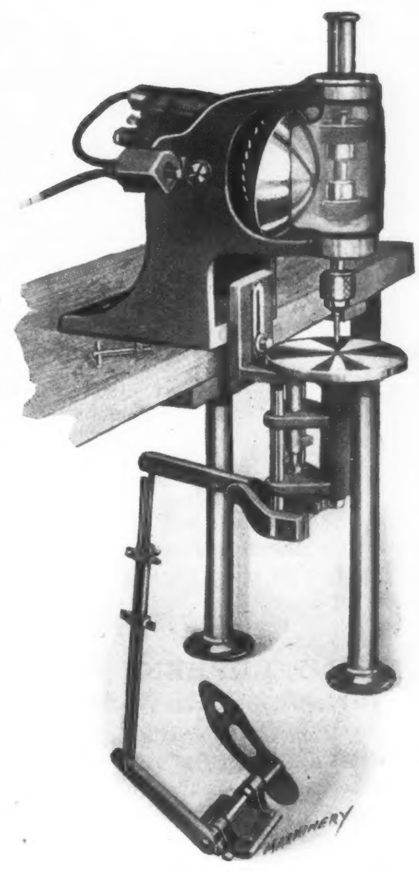


Fig. 2. View of Anderson Tapping Machine, showing Treadle and Springs to take up Inequality of Foot Pressure and counterbalance Weight

The column or body which supports the table is hollow to provide a chamber that can be filled with oil, so that when tapping work where the tap can go through it will dip into the oil, which results in lubricating the tap and washing off the chips so that they will not injure the thread when the tool is backed out. As the chamber becomes filled with chips, the oil level is maintained until exhausted or displaced by chips, and the chips can be removed by taking out the plug at the bottom of the chamber.

The motor is pivoted in the frame of the machine at the center of the spherical face of the friction driving disk which, it will be recalled, is mounted on the armature shaft. By tilting the motor, various cutting and return speeds may be secured. It will be evident that if the speed is reduced in either direction, it will be increased in the opposite direction. For instance, if the motor is so placed that the spindle runs at the same speed in both directions, say 1000 revolutions per minute, this gives a combined figure of 2000. The motor can then be changed to secure a speed of, say, 500 revolutions per minute in the forward direction and a reverse movement at the rate of 1500 revolutions per minute, thus maintaining the same combined figure. With one type of motor commonly used on these machines, two amperes of current are used at 110 volts, making the cost of power per hour, at six cents per K.W.H., 0.0132 cent. A switch of special design, a reinforced cord and attachment plug, and the necessary wrenches for

making all adjustments form part of the regular equipment.

Chucks may be furnished of the form shown in the illustrations, but unless otherwise specified, the machine is regularly equipped with a two-jawed positive drive chuck, which is considered best for general classes of work. Guards are provided to protect operators from injury and to prevent oil from being thrown. The principal dimensions of the machine are as follows: distance from spindle center to slide, 4 inches; diameter of spindle, 3/4 inch; diameter of table, 7 inches; maximum vertical adjustment of table, 3 inches; and weight of machine, 115 pounds net. The capacity of the machine is for tapping holes in cast iron from 1/16 to 1/4 inch in diameter, and for tapping holes in steel from 1/16 to 3/16 inch in diameter; and holes up to 1 1/2 inch in depth may be tapped for all classes of work.

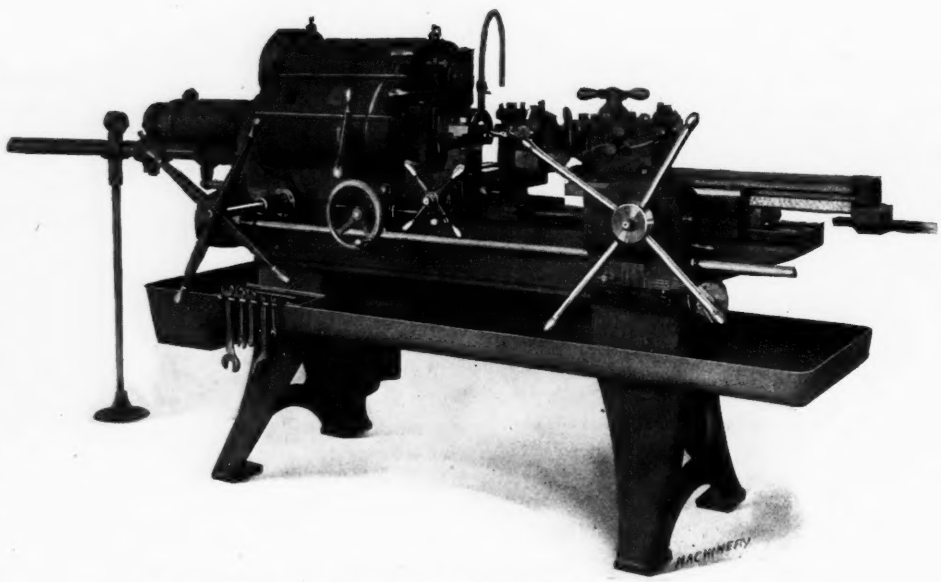


Fig. 1. Foster No. 5 Screw Machine with All-geared Head and Bar Equipment

TOOL EQUIPMENT FOR FOSTER NO. 5 SCREW MACHINE

The efficiency and productive capacity of a screw machine depend to a large extent on the quality of the tools employed. Not only can the production on what is commonly regarded as screw machine work in its narrow sense be increased to a considerable extent by the use of better designed and more rigid tools, but by means of additional equipment, the range of work which can be handled to advantage on the screw machine can be greatly widened and be made to include almost all kinds of chucking work.

The Foster Machine Co., Elkhart, Ind., has designed and is now building a complete new line of tools for the No. 5 screw machine. This machine has recently undergone several changes of design, and is now being built in two different styles, *viz.*, the back-geared cone head type and the all-geared head type. The latter is illustrated in Fig. 1, and the new bar equipment is shown mounted in place.

Bar Tools

Perhaps the most widely used of all screw machine tools is the one that is commonly known as a roughing box-tool or single cutter turner, a new design of which is shown at *A*. Two features of this tool that stand out prominently are its extreme rigidity and convenience of operation. As shown, the cutter is held in a manner to insure maximum economy of high-speed steel. The two roll jaws are independently adjustable and rigidly secured to the tool body by means of a bolt, the body being split for this purpose. The cutter-slide is equipped with a release to prevent marring the work when withdrawing the tool, which is operated by means of the bent handle in front of the tool. This handle also serves the purpose of binding the cutter-slide rigidly to the tool body. For convenience of setting, the slide operating screw is equipped with a graduated dial.

The multiple cutter turner shown at *B* is also noteworthy for its rigidity. This tool is shown equipped with two double tool-holders, enabling four cuts to be taken simultaneously, and one roller back-rest. The tool can, however, be equipped with three double tool-holders for taking six cuts simultaneously, and two roller back-rests. One important feature of this tool is that shoulders only 1/4 inch apart can be turned with it. The pointing tool *C* is different from the two former tools in that it is provided with a shank for holding in the turret holes. The roller back-rest jaws are independently adjustable and interchangeable with those of the single cutter and the multiple cutter turners. In addition to the pointing cutter, tool *C* is designed to carry a centering drill. At *D* is shown a new design of adjustable hollow-mill. This is a cheap tool of great rigidity, and can be used to advantage on short work where much stock is to be removed rapidly.

Miscellaneous Tool-holders and Adapters

Simplicity of design and rigidity were striven for in designing the center drilling tool *E* and the knurling tool *F*.

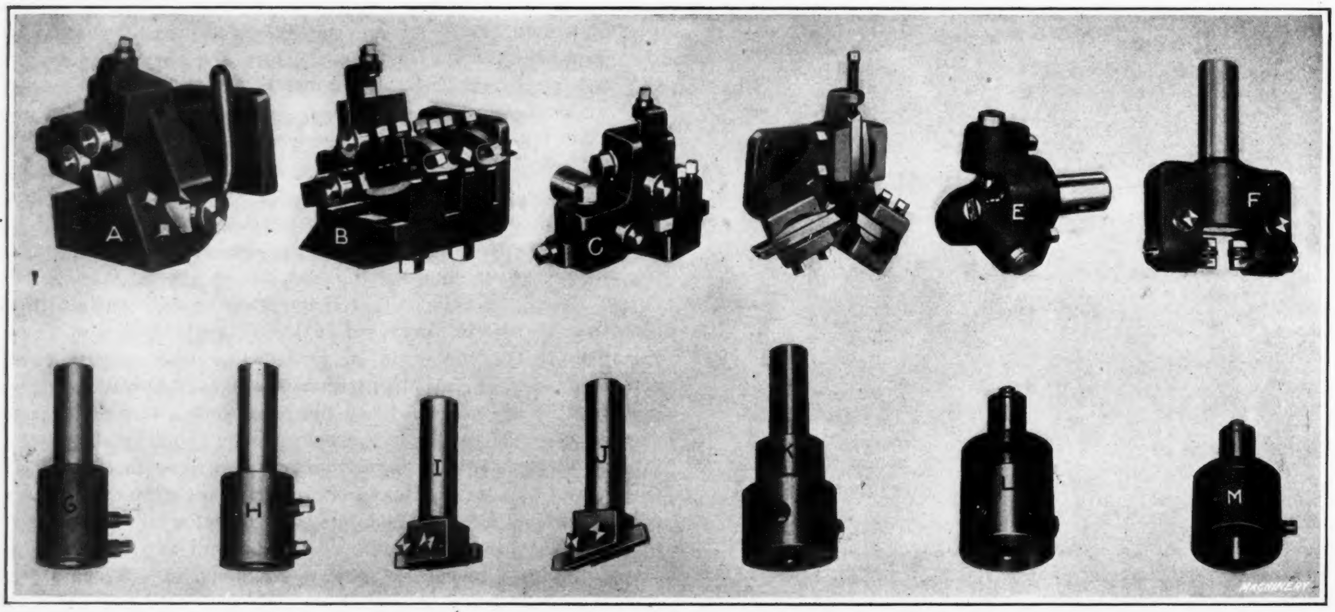


Fig. 2. A, Roughing Box-tool; B, Multiple Cutter Turner; C, Pointing Tool; D, Adjustable Hollow-mill; E, Center Drilling Tool; F, Knurling Tool; G to J, Tool-holders; K, Drill-holder; L, Tap-holder; M, Die-holder

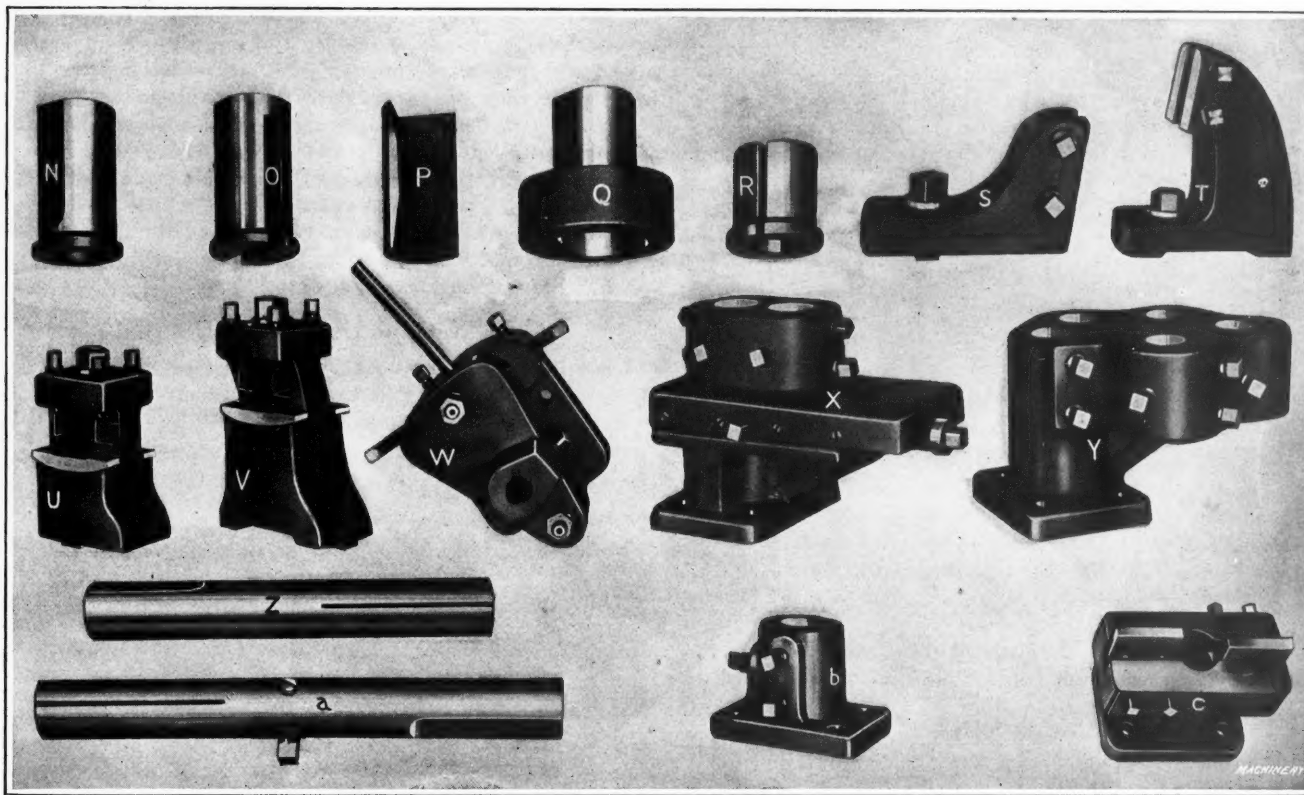


Fig. 3. N to R, Adapters; S and T, Forming Tool-holders; U and V, Double Tool-holders; W, Recessing and Back-facing Tool; X, Tool-slide for Use in recessing and back-facing; Y, Multiple Turning Head; Z, Pilot Bar; a, Boring-bar; b, Adapter; c, Facing Tool

The working principles of these tools can be readily comprehended by reference to the illustrations. From *G* to *J* are shown the tool- and cutter-holders that go with the equipment, and attention is called to the holder *G* that has a floating device which compensates for any error of alignment between the hole in the work and the center of the turret, thus preventing the reamer or other tool carried in it from cutting over size. The drill-, tap-, and die-holders, *K* to *M*, inclusive, are of standard and approved design. The spring die adapter *Q*, Fig. 3, is made to fit die-holder *M*, and adapters *N* to *R* are made to fit any of the tool-holders and also the turret hole.

Tool-holders for Cut-off Slide

The four holders *S* to *V* are furnished in addition to the regular cut-off slide tool-holders provided with all standard screw machines. The two forming tool-holders, one for the front and one for the rear, are of the dovetail type, and are split for the purpose of clamping the forming tool to the holders by means of two screws on the side. The double holders enable two cuts to be taken or two shoulders to be necked simultaneously, and are equipped with rocker wedges for adjusting the height of the cutter point.

Chucking Tools

Chucking work, as a rule, is not considered to fall within the scope of work for which the screw machine is peculiarly adapted. However, with a three-jaw scroll chuck and a complete line of chucking tools, a large and varied range of work belonging to this general class can be handled to advantage in small as well as large lots. The tool shown at *W* has been found to be peculiarly well adapted for recessing, back-facing and also for boring work in small quantities. The tool-carrying member swings around a pivot underneath the cutter and is operated by a handle. The two radial screws seen in the illustration provide adjustment and also act as stops for gaging the depth of cut. The tool-slide *X* is intended for the same general type of work, but is more rigid and has a much larger range of work; it can be used to advantage for back-facing hubs of gears and similar operations.

The multiple turning head *Y* is intended for the general run of turning and facing work. A pilot bar *Z*, carried in the center hole of the turning head, runs in a bushing held in the spindle and supports the tool against chatter. The cutter-holders *I* and *J* are primarily intended for use in this turning head. For simultaneously boring and turning, a boring-bar *a* can be held in the center hole and brought into action at the same time as a cutter-holder held in either of the other holes. The holder *b* is for adapting either of the tool-holders or the boring-bar to the turret. By means of the rocker adapter and the two set-screws on the top of the holder, a forged cutter can be adapted to the holder and adjusted for diameter.

ANDERSON DIE FORMING MACHINE

In the October, 1915, number of MACHINERY a description was published of the die forming machine which had just been placed on the market at that time by the Anderson Die Machine Co., 590 Water St., Bridgeport, Conn. It will be recalled that the machine described at that time was equipped with electric motor drive. Recently this firm has introduced a belt-driven machine of essentially the same design to meet the requirements of shops in which electric power is not available, or where for any reason belt drive is preferred.

MOORE & WHITE HIGH-SPEED FRICTION CLUTCH

With the growing use of anti-friction lineshaft hangers and of machine tools designed for high-speed steel tools, there has come a general tendency to use higher speeds for factory shafting. Aside from metal working machinery, other machinery, such as grinding and polishing machines, wood-working machines, fans and electric motor drives, have always called for high speeds; and the necessity of having friction clutches especially adapted to high-speed conditions has become apparent. The clutch here shown was especially designed for speeds at which the ordinary wood block type of friction clutch will not operate successfully. It is of the metal-to-metal type, having bronze disks alternating with cast-iron. The disks are lubricated, but do not run in an oil bath. They are fully enclosed, and all important parts are machined all over so that the clutch is perfectly balanced. The engaging mechanism is such that there is no tendency to grab or drag when the clutch is released. A very accurate adjustment can be had.

This clutch is made in loose pulley and cut-off coupling types. From the following description of the loose pulley type, the cut-off coupling type will be understood. In the sectional view, Fig. 3, hub *A* is keyed to the shaft and drives or is

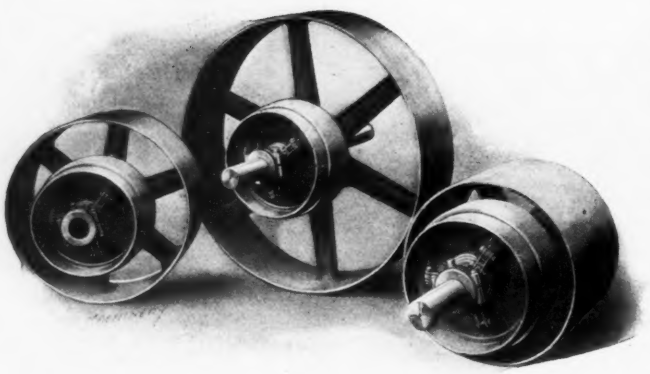


Fig. 1. High-speed Friction Clutch Pulleys equipped with Moore & White Clutches

driven by the cast-iron disks *B* through a series of pins *C*, which slidably connect the hub and the follower *D*. This follower is bored to pass over lugs cast on the pulley sleeve *E*. Between the hub and follower is a threaded adjusting ring *F*. The operating levers *G* and *H* are attached to the hub, and act against the adjusting ring when the spool *I* is forced into the position shown. The adjusting ring is thus forced to the right, carrying with it the follower, and the hub is forced to the left, thereby engaging the disks.

The bronze disks *J* are slotted and slide on the lugs of sleeve *E*, thereby communicating power to the latter. Springs *K* free the disks when the clutch is released. Sleeve *E*, carrying the loose pulley, runs on the divided bronze bushing *L*, which

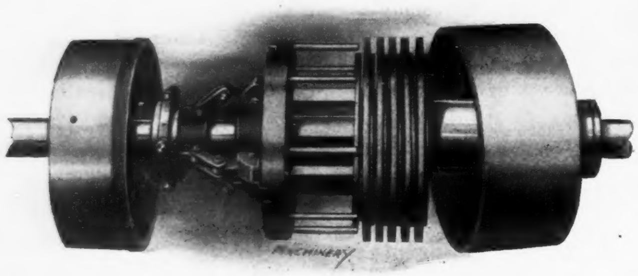


Fig. 2. Moore & White 21-inch High-speed Friction Clutch Pulley partially disassembled

is keyed to the shaft and grooved to distribute oil. The central space holds oil, and feeds it by gravity to the running surface as long as any remains. The oil retaining collar *M* is attached to the sleeve, not to the shaft, and is therefore not affected by centrifugal force. This lubricating arrangement is of the utmost importance at high speeds, as it holds the oil where it belongs and protects both the running surfaces and surrounding objects which might be damaged by flying oil. In the cut-off coupling the extended sleeve is omitted and a small bushing is used to hold the two shaft ends in line.

The clutch is made in sizes from 5 to 25 inches diameter of bronze disks. Each size has from one to six disks, according to the capacity desired. The smallest size can be run up

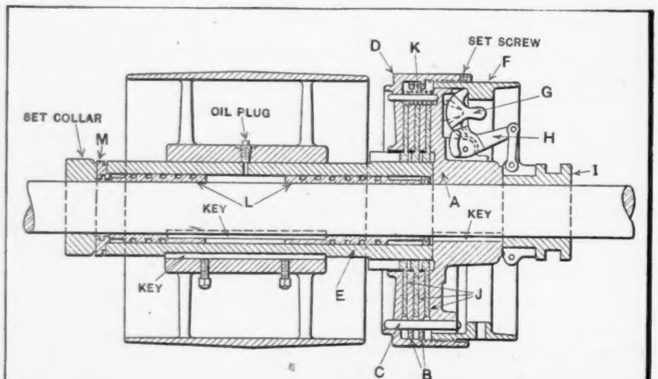


Fig. 3. Sectional View of Moore & White High-speed Friction Clutch

to 3000 revolutions per minute and the largest size up to 750 revolutions per minute. Powers transmitted are up to 630 horsepower. In sizes from 5 to 13 inches the clutches can be fitted directly on an extended hub of the pulley, gear or other member. These clutches are recommended for use with alternating-current motors when required to start under load, also for group drives to high-speed machinery and individual drives to wood-working and other heavy high-speed machines. They are made by the Moore & White Co., 2707-2737 N. 15th St., Philadelphia, Pa.

QUICK-OPERATING CUTTER

When it is necessary to make an additional hole in a cabinet to accommodate a piece of conduit or to make a hole in a

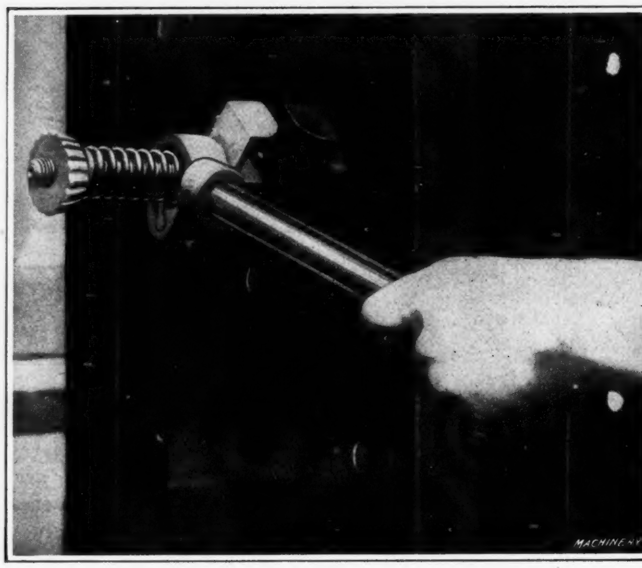


Fig. 1. Arrangement of Chuck, Feed Spring and Ratchet Wrench

metal locker or to do other work of this kind, considerable trouble is often experienced in finding a tool that will handle the job satisfactorily. Recently a tool has been developed for this purpose that can be used for cutting all sorts of metal, fiber and slate, and it can be adjusted to cut holes of various sizes with little effort and at high speed. To use this tool it

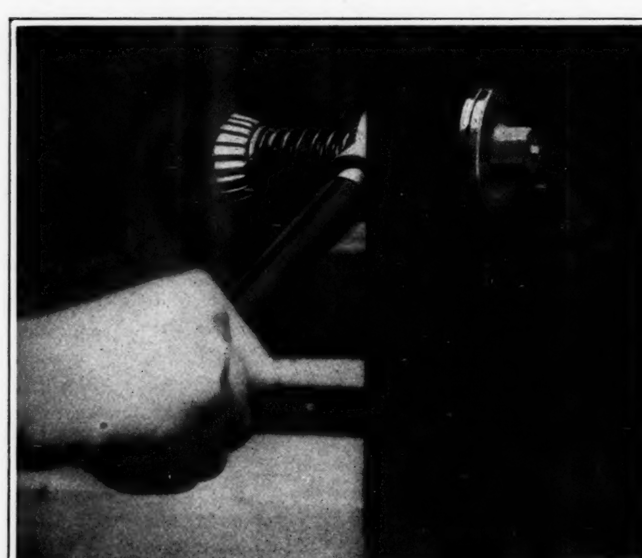


Fig. 2. Flanged Nut secured to Stud on Inside of Plate to be bored

is merely necessary to first drill a hole through the material in order to provide space for a stud on the end of which a flanged nut is secured. Then a few turns of a ratchet wrench results in cutting out a neat hole. An idea of the rate at which work can be done will be gathered from the fact that during a recently conducted test a hole was cut in the wall of a standard conduit cut-out box (about 0.1 inch thick) by

fourteen revolutions of the cutter, and the entire job was completed in less than a minute.

The accompanying illustrations show one of the uses of this tool, and in this connection it may be mentioned that the knives may be adjusted for cutting holes of various diameters. The knives are held in a chuck and are automatically fed to the work by means of a spring located between the chuck and nut. This device does the work of a drill press, and it is particularly useful in many cases because the tool can be taken to the work instead of requiring the work to be carried to a machine. In cutting holes in tanks and similar places where the flanged nut cannot be secured to the stud on the inside, it is merely necessary to tap the pilot hole and screw the stud into this hole. The uses mentioned are only a few of the applications which can be made of this tool. It is made by the Universal Mfg. Co., Stroh Industrial Bldg., Milwaukee, Wis.

WOOD & SAFFORD CYLINDER GRINDER

For use in regrinding the cylinders of automobile engines and small traction engines, the Wood & Safford Machine

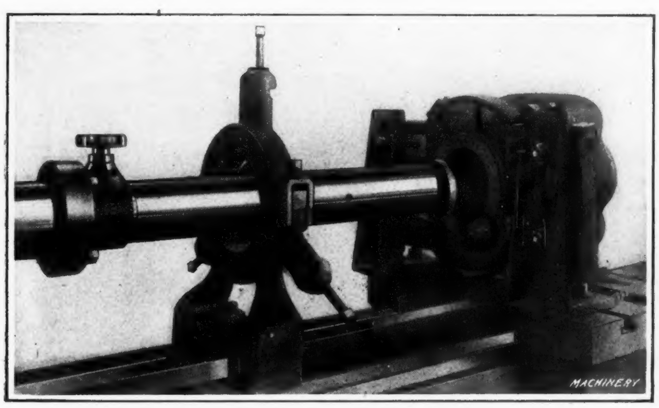


Fig. 1. "Perfection" Cylinder Grinder made by Wood & Safford Machine Works for Use on Engine Lathe

Works, Great Falls, Mont., have developed a cylinder grinding attachment known as the "Perfection" cylinder grinder, which can be used on any ordinary engine lathe having a hollow spindle and a swing of not less than 14 inches. This attachment consists of a grinding wheel carriage or spindle mounted on the lathe spindle in place of a chuck; one adjustable angle-plate; two angle-plate supports, which can be adjusted to fit any size of lathe, these supports being mounted on the front end of the carriage; one centering device for locating the cylinder on the angle-plate in a position central with the grinding bar; one countershaft; five carborundum wheels; one diamond wheel dresser; and the necessary clamps and cap-screws for fastening the cylinders to the angle-plate. The capacity of this grinding attachment is for cylinders from 3¼ to 6½ inches in diameter, and an extension may also be provided for regrinding cylinders from 1½ to 3¼ inches in diameter, such as those in motorcycle engines.

One of the most important features of this outfit is the

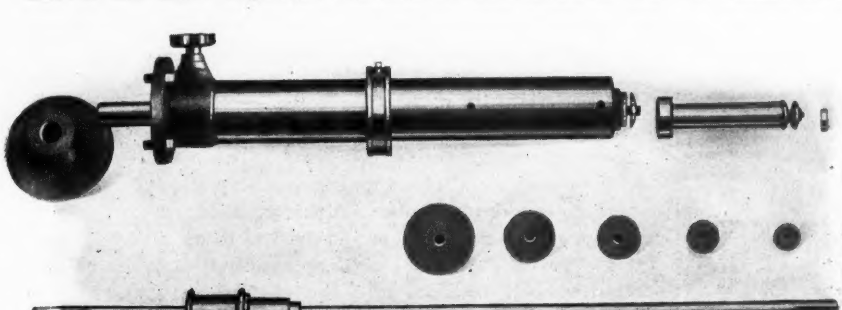


Fig. 2. Grinding Spindle and Wheels used on Wood & Safford Grinder

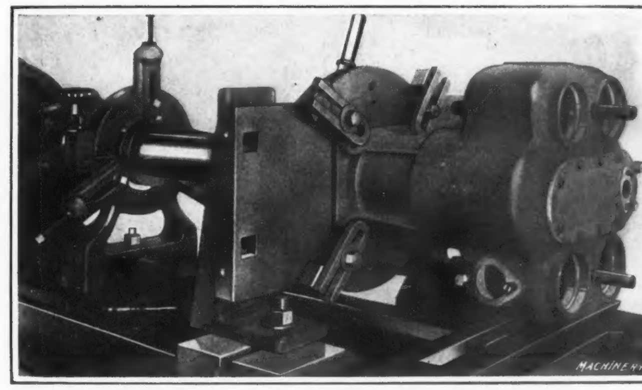


Fig. 3. Cylinder secured in Place on Angle-plate ready to be ground

micrometer attachment for enabling the operator to adjust the grinding wheel to within 0.0005 inch of the desired position. To attach the grinding spindle to a lathe for the first time it will be necessary to machine the rough flange casting to fit the lathe spindle where the faceplate or chuck is screwed on; also it will be necessary to machine the cast-iron bushing which fits into the outer end of the hollow spindle. After this has been done, it is an easy matter to set the attachment up ready for use.

The grinding spindle is made of steel tubing and holds one quart of oil. This spindle is fitted with an adjustable tapered bearing. The grinding wheel is located ⅞ inch off center, thus giving the wheel a planetary motion on a circle 1¾ inch in diameter. The angle-plate that supports the cylinder block is made of reinforced cast iron, and a hole in the center of this plate is 6⅜ inches in diameter with a 5-inch cast-iron bushing. The centering device fits in this bushing, enabling the cylinder to be located in the correct position relative to the grinding wheel before the work is clamped to the angle-plate.

GEOMETRIC THREADING MACHINE

The Geometric Tool Co., New Haven, Conn., is now making a smaller size of the threading machine of its manufacture which is well known to the machinery trade. Formerly the

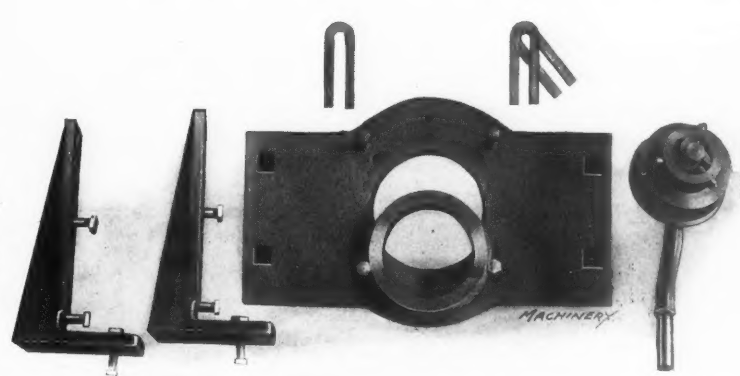


Fig. 4. Angle-plate, Clamps, etc., for holding Work on Machine ready for grinding

smallest size in which this machine was built was a nominal ¾-inch size, with a capacity for handling threading operations on pipe from ¼ to ¾ inch in diameter. The new machine is known as a ½-inch size, and may be used for threading ⅛-, ¼-, ⅜- and ½-inch pipe.

HIGH-SPEED RIVETING MACHINE

The No. 3A heavy-duty riveting machine illustrated and described herewith has recently been placed on the market by the High-Speed Hammer Co., Rochester, N. Y. It is essentially adapted for miscellaneous riveting operations in automobile factories where there are numerous jobs which come within the range of this machine, which is for handling rivets from 1/4 to 7/16 inch in

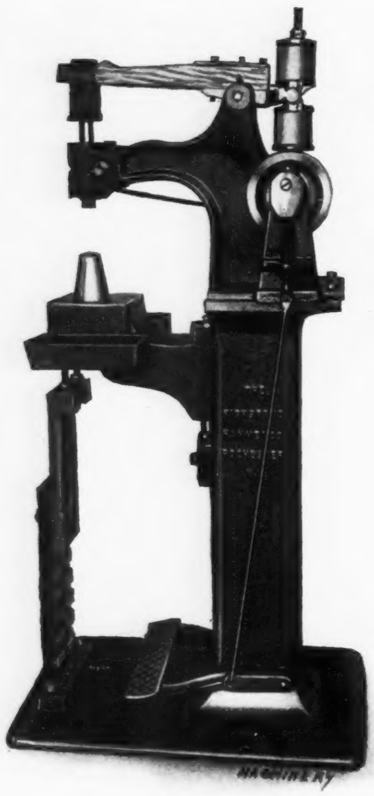


Fig. 1. High-speed No. 3A Heavy-duty Riveting Machine

diameter. The adjustable supporting column for the table is one of the important features of this machine, and the same device is now used on other machines built by the High-Speed Hammer Co. It will be seen that this support is made in two parts, adjustment for fixed distances being made by loosening one screw and then raising or lowering the upper member of the support so that it engages the next notch on the lower member. The binding screw is then tightened, after which fine adjustment is obtainable by manipulating the screws in the upper member which engage with the table.

These riveting machines are of the so-called "elastic blow" type, being provided with two heavy rubber bumpers at the rear of the machine and a third bumper placed between the hammer head and the helve. The shock of rebound is absorbed by the hickory helve. The construction of the clutch is such that the number of blows may be varied from the maximum to any lesser number by simply varying the pressure of the foot on an operating treadle. This is easily accomplished by a simple friction drive clutch which is employed in place of a positive clutch. Phosphor-bronze bushings are used in all bearings throughout the machine, and drive to the hammer is provided by a worm, worm-wheel and round belt. This machine has a gap 18 inches deep by 8 inches high, and the capacity is for handling rivets from 1/4 to 7/16 inch in diameter. It is recommended that the hammer be driven at from 1600 to 1700 revolutions per minute. The floor space occupied is 15 by 26 inches, and the net weight of the machine is 470 pounds.

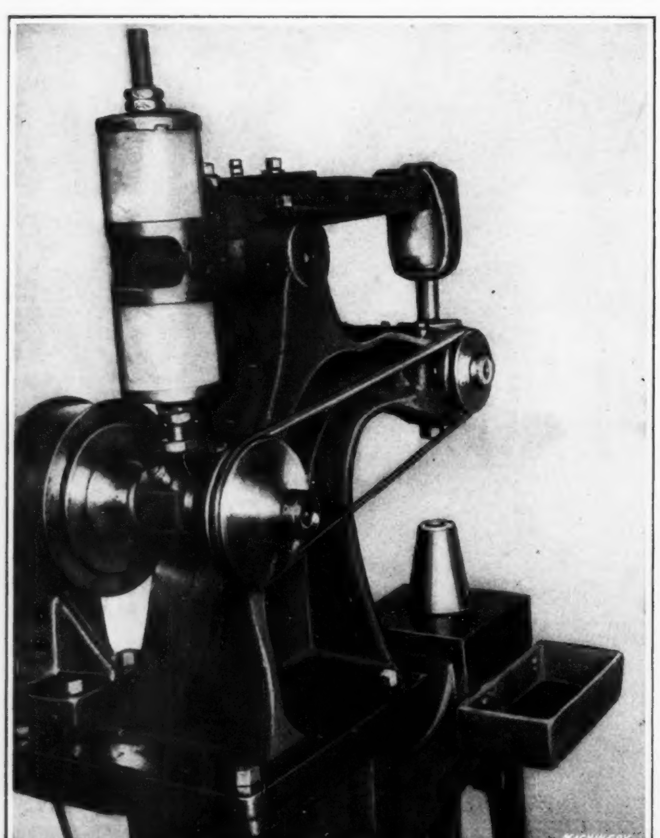
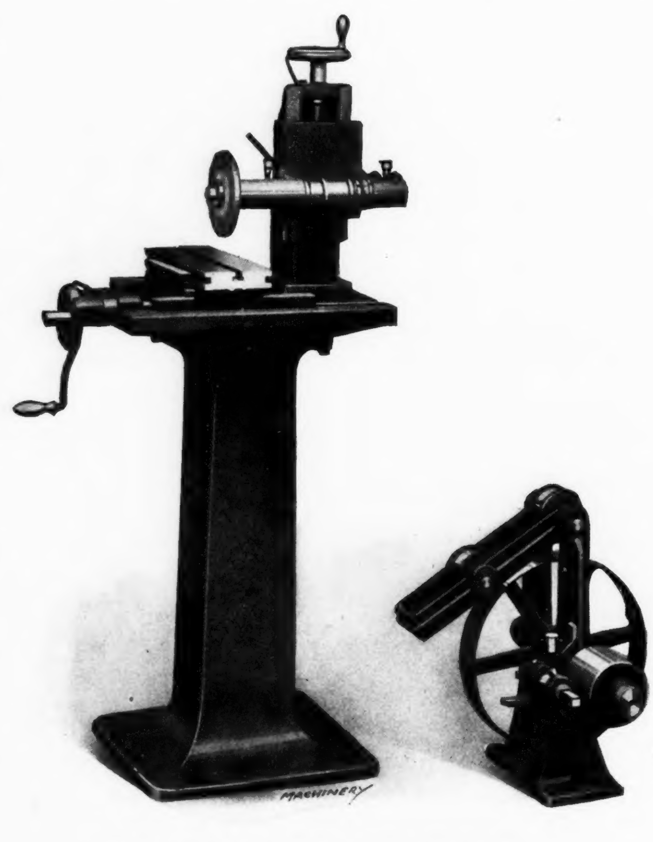


Fig. 2. Close View of Opposite Side of High-speed Riveting Machine

AMERICAN NO. 1 SURFACE GRINDER

The American Machine Tool Co., Hackettstown, N. J., is now building the No. 1 surface grinder shown in the accompanying illustration. This grinder is designed for doing accurate work on dies, punches, gages and small machine parts, being heavily constructed to insure rigidity and accuracy of the product. All sliding surfaces are provided with adjustable gibs, and the handwheels on the traverse feed and elevating screws are each provided with an indicator and graduated to 0.001 inch, thus affording means of making fine adjustments in all directions.

The table is moved endwise by a crank fitted to the square end of a shaft operating a pinion which, in turn, meshes with a rack on the bottom of the table. This gives a rapid, easy movement without tendency to bind; and the crank can be easily removed and used on the square shaft in front of the handwheel on the traverse feed if faster movement is desired. The spindle slide works on a rigid upright provided with scraped ways, and the spindle is made of crucible steel, accurately ground and fitted in scraped bearings. There are no caps to work loose and cause vibration, as both bearings are cast solid, the front bearing being tapered to fit the spindle and the rear bearing solid but split on one side to provide means of compensating for wear. The spindle is provided with take-up nuts for adjusting end play and wear.



No. 1 Surface Grinder built by American Machine Tool Co.

There is only one pulley on this grinder, which is the arbor pulley. As shown, the countershaft is in an inverted position. It is provided with a tightener which always maintains the required belt tension, and the shifter rod is always in a perpendicular position. There is no weight on the belt to cause it to shift off the pulley, and a simple twist of the rod suffices to shift the belt. The regular equipment furnished

with the grinder includes a set of wrenches and one emery wheel.

The principal dimensions of this machine are as follows: capacity for surface grinding operations on work 9 by 6 by 5 inches in size; maximum traverse of table, 9½ inches; size of front spindle bearing, 1¼ by 5 inches; size of rear spindle bearing, ⅞ by 2¾ inches; length of feed handle, 7 inches; size of emery wheel, 6 inches diameter by ⅜ inch face width; height from floor to top of table, 36½ inches; size of table, 15 by 5 inches; adjustment of table in line with spindle, 6 inches; spindle adjustment above table, 1 to 7½ inches; height from floor to top of handwheel on raising screw, 51½ inches; floor space occupied, 27 by 23 inches; and weight of machine, about 500 pounds.

SOUTHWARK SCRAP RECLAIMING PRESS

For reclaiming scrap material and repairing steel cars, the Southwark Foundry & Machine Co., Philadelphia, Pa., is now building the Southwark-Gross press illustrated and described herewith. Adoption of all-steel equipment in railroad rolling stock created a demand for a press to be used in reclaiming from the scrap heap bent and damaged parts of wrecked cars,

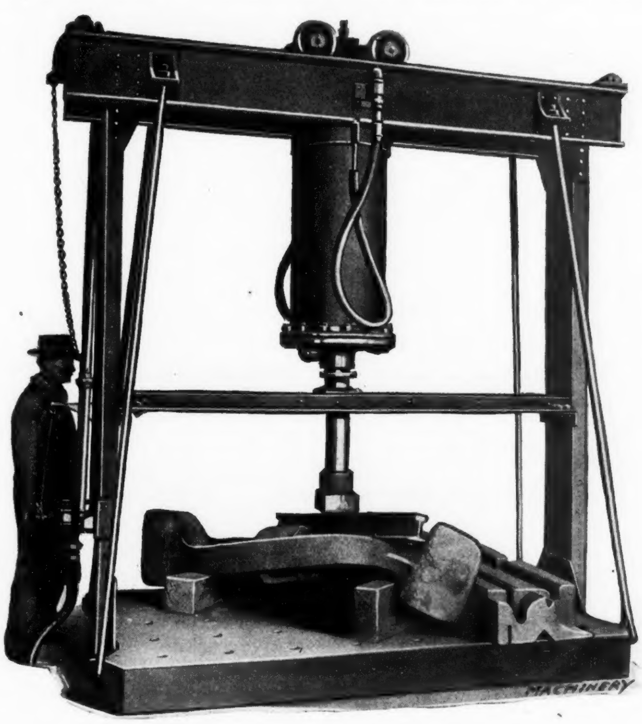


Fig. 1. Straightening a Bent Truck Frame on Southwark-Gross Press

and for various other pressing operations in railroad repair shops. Its use is not in any way confined to railroad work, however, as the press is suitable for various miscellaneous pressing operations.

The base of the Southwark-Gross press is a heavy steel casting with a flat surface which forms a foundation for the structural steel frame that consists of two steel uprights supporting a main cross frame. The top of this frame is braced by heavy tie-rods attached to the four corners of the base. Provision is made for suspending the cylinder from the cross frame by means of a four-wheeled carriage, and travel of the ram is controlled by means of a balanced type four-way valve located in a position convenient for the operator. The carriage is moved back and forth across the top frame by an endless chain traveling over sprockets. A piston-rod guide is supported between two angle-irons fastened to the vertical columns. The piston is 20 inches in diameter and has a maximum stroke of 36 inches; it is packed with leather cup packing, which can be quickly renewed when necessary. The die is fitted to the end of the piston-rod, and can be changed in the same way that dies are changed on a steam hammer. Air is supplied to the double-acting cylinder by a flexible hose connection of sufficient length to permit free movement of the cylinder as it travels across the table. For straighten-

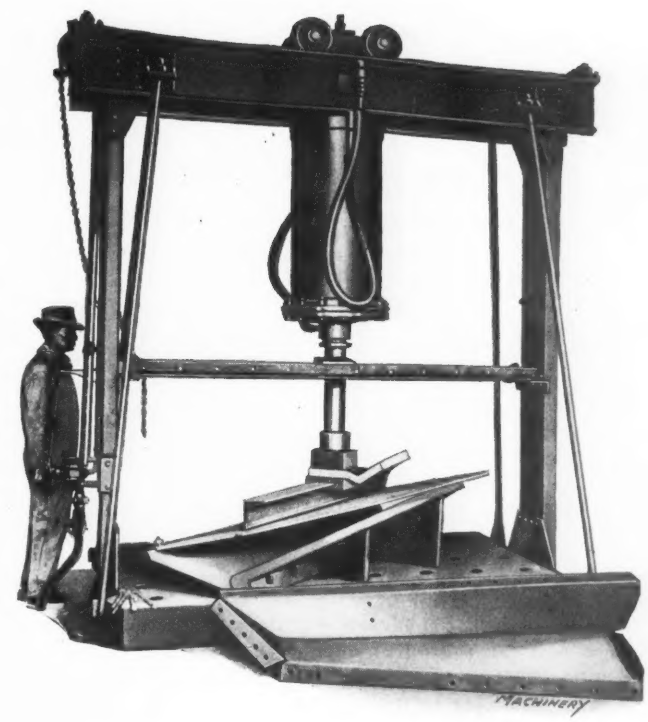
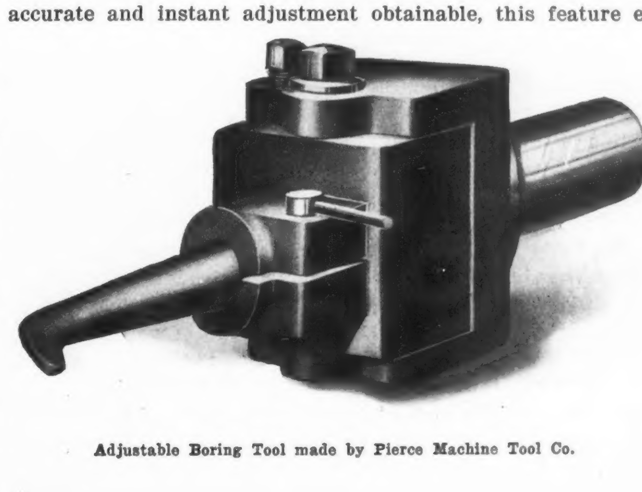


Fig. 2. Use of Southwark-Gross Press for Performance of Forming Operations

ing bent truck frames, center and side sills, side sheets, channels, angles, truss rods, etc., this new press will be found to effect a great saving in time and labor; it is also convenient for forming hopper sheets, bending guard rails and other work required by locomotive and car maintenance-of-way departments. In most cases work requiring bending or straightening can be handled cold, but in certain instances where extra-heavy work is being handled it is safer to heat the metal before subjecting it to a pressure of fifteen tons, which is the capacity of this press. An attempt to bend such work cold is likely to result in cracking the metal, but with modern means of welding, such as the oxy-acetylene process and similar methods, cracks of this kind are not serious, as repairs may be made very quickly, and the repair has a strength practically equal to that of the original metal. The principal dimensions are as follows: size of base platen, 5 by 8 feet; bore of pressure cylinder, 20 inches; length of stroke of piston, 36 inches; diameter of piston-rod, 4⅞ inches; size of air hose, 1¼ inch; clear height under die, 36 inches; and pressure capacity for an air pressure of 100 pounds per square inch, 15 tons.

PIERCE ADJUSTABLE BORING TOOL

The accompanying illustration shows the Pierce adjustable boring tool designed for general boring operations, the work being done with a forged tool having a shank ½ inch in diameter. One of the important features of this tool is the accurate and instant adjustment obtainable, this feature en-



Adjustable Boring Tool made by Pierce Machine Tool Co.

abling maximum production to be obtained from both the tool and machine. The absolute rigidity of the tool enables it to be used for the most accurate classes of work. The clamping arrangement is positive, and the tool is easily adjusted to the required size. In adjusting, it is merely necessary to loosen the collar screw and make the required adjustment of a set-screw the point of which seats on an incline, forcing the adjustable swivel block outward and thus moving the cutting tool to the required position. The finest adjustment can be quickly made by this means.

The cutting point is always central and on the correct line when boring, regardless of any adjustments for size that may have been made; consequently, it is unnecessary to change the cutting point to suit the adjustment of the tool. The cutting tool is quickly clamped in position by a convenient lever which insures instant and positive grip and eliminates the use of wrenches. The standard shank furnished on this tool is 1 inch in diameter, but any desired shank can be made to order. This tool is manufactured by the Pierce Machine Tool Co., 617 W. Jackson Blvd., Chicago, Ill.

SOUTHWARK UNIVERSAL FLUE WELDER

The Southwark Foundry & Machine Co., Philadelphia, Pa., is now building the universal flue welder illustrated and described herewith. In working out the design, particular attention has been paid to the provision of the essential features required to meet conditions which have arisen in flue welding since the general adoption of the locomotive superheater. A clamping head at the front and driving mechanism at the back are the two main parts of this machine. The clamping head is made from one circular shaped casting with four air cylinders mounted on the inside. Metal snap rings are provided on the pistons instead of the cup leather type; and the front ends of the piston-rods are equipped with sectional dies which clamp the outside of the flue at the line of weld.

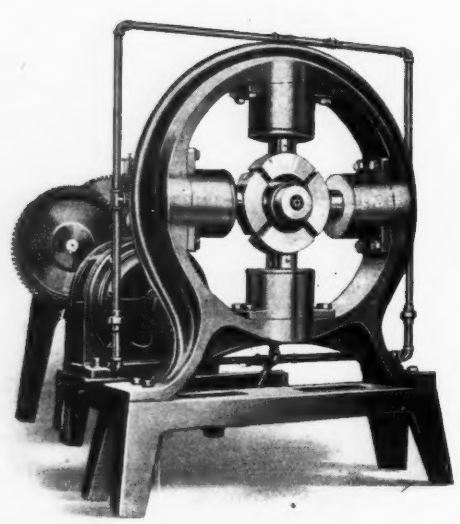


Fig. 1. Front View of Southwark Universal Flue Welder, showing Clamping Head

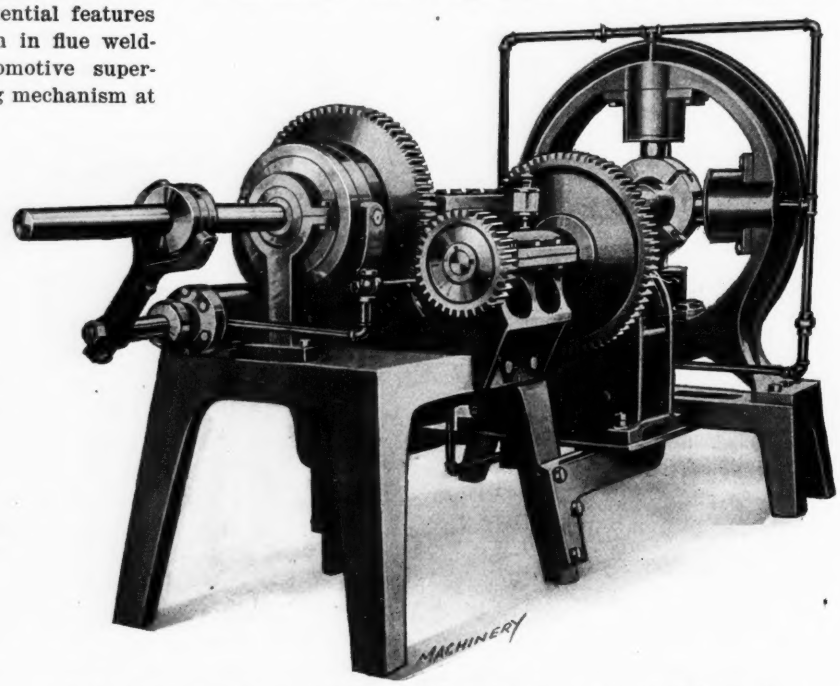


Fig. 2. Three-quarter View of Southwark Flue Welder from Opposite End, showing Driving Mechanism

Piped up to a single air line, the cylinders operate simultaneously with the opening of the valve. Running through the center of this head longitudinally is a welding mandrel which fits inside of the flue. Four rollers are assembled in the body of this mandrel, which is hollow. These rollers can be moved radially by a tapered mandrel which reaches through the middle of the spindle from the back end of the machine. This mandrel is operated by an air cylinder that is also controlled by the main foot valve. The main mandrel is driven through two gear reductions from a 1½-horsepower motor.

An adjustable platform in front of the welder head, which supports the welding furnace, permits the proper location of different lengths of "safe ends"; and a cast-iron tank or water-back protects the welding head from the excessive heat of the furnace. The size of the mandrel back of the welding rollers approximates the inside diameter of the flue. This supports the weight of the safe end while being heated and moved to the welding position, thus preventing loss due to dropping of the safe end. Standing away from the furnace, the operator uses a foot valve which controls the entire operation of the welder, the piping being so arranged that the clamping heads close in on the outside diameter of the flue before the taper mandrel expands the rolls to provide for making the weld. It is customary to rig up the front end of the machine with some type of roller table to support long flues. With this equipment a crew can easily weld 120 superheater flues in a day.

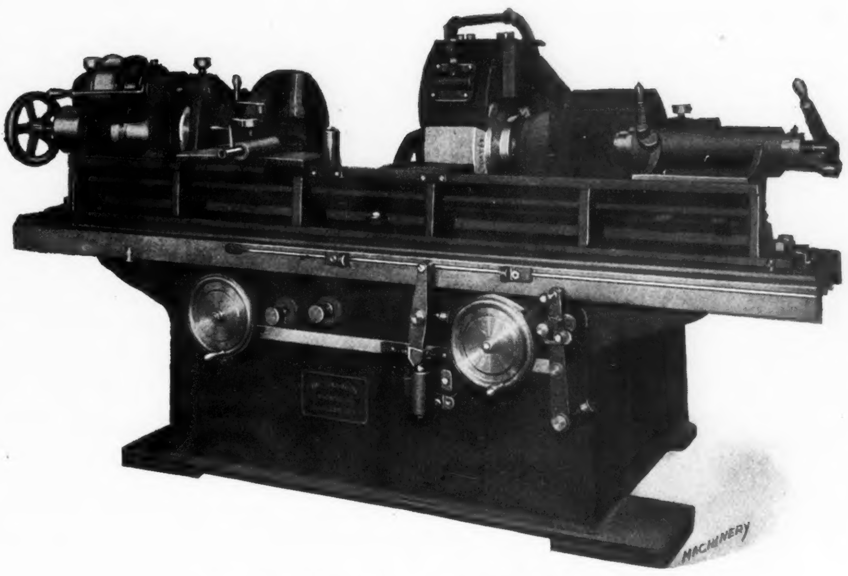
FORD-SMITH HEAVY-DUTY GRINDER

The Ford-Smith Machine Co., Ltd., corner Princess and Earl Sts., Hamilton, Ont., Canada, has recently placed on the market a combination traverse and form grinder which is adapted for both standard and special cylindrical grinding. While this machine is designed for standard cylindrical work, the headstock is so arranged that any special requirements can be easily met. This machine has recently proved very successful in grinding large punches used in the manufacture of shrapnel and high-explosive shell forgings. These punches range from 3 to 6 inches in diameter, and vary in length from 2 to 5 feet.

In grinding a shell forging punch the threaded end and parallel part of the punch pass into the hollow spindle and are gripped in the chuck with the formed end out; this end is then ground with a wide form wheel to exactly the required shape. As many as are required are thus ground. The punch is then put on centers, the formed end running in a ball bearing cup center. The form wheel (on a special wheel center) is then removed and a 22- by 2½-inch traverse wheel substituted, after which the punch is ground parallel, as in a regular traverse grinder. Worn punches can thus be kept in repair at small expense, as the necessity of annealing and re-hardening is eliminated. Saving in this direction and through the production of better forgings quickly pays for the equipment. This work indicates the line of usefulness of a grinder built heavily enough to carry form wheels up to 8-inch face and equipped with a hollow spindle to allow gripping the work close up, having, in addition, the usual cylindrical traverse grinding features.

The headstock, as stated before, can be arranged to suit any requirements desired. The work is held by means of a universal chuck, together with a special interior centering arrangement inside the hollow spindle. Numerous changes of speeds and feeds are provided, all levers being situated at the

front of the machine within reach of the operator. The wheels used are 22 inches in diameter by whatever width is required for the work to be ground. A special truing device is attached to the machine table, making it an easy matter to keep the wheel in first-class shape. Water is supplied to the wheel by a pump of ample capacity at the rear of the machine, from a tank cast on the bed.

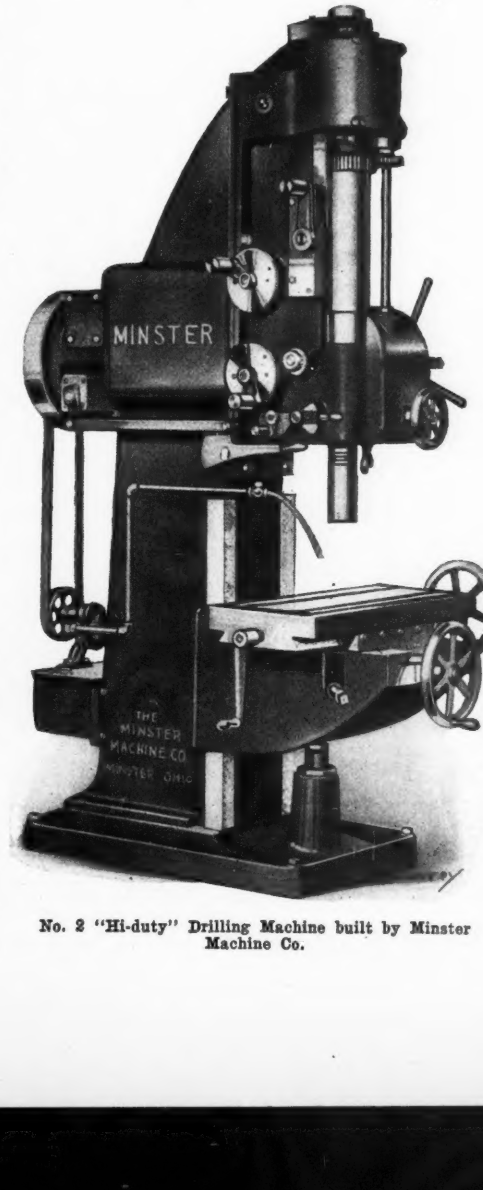


Heavy-duty Grinder built by Ford-Smith Machine Co.

Careful attention has been paid to the design of the wheel hood, which is both convenient in use and also in changing wheels. The drive is self-contained, and the machine may be direct-connected to a motor or driven from the lineshaft, as required. This machine has a large capacity, swinging 18 inches by 5 feet between centers, with adjustment for taper grinding. It has been simply and carefully designed all through for extremely heavy duty, and all parts are of rugged construction, thus eliminating vibration. Twenty horsepower is required for form-grinding and ten to fifteen horsepower for traverse grinding. The floor space occupied is 6 by 15 feet, and the weight of the machine is 14,000 pounds.

MINSTER "HI-DUTY" DRILLING MACHINE

The No. 2 "Hi-duty" drilling machine which forms the subject of the following description is manufactured by the Minster Machine Co., Minster, Ohio. This machine is designed with sufficient strength and power to drive a 2½-inch high-speed drill in solid steel at a speed and feed which insures obtaining the maximum production from the drill. The machine is provided with a wide range of feeds and speeds which enables the user to operate it economically on a variety of work. Owing to the high spindle speeds which are available, the machine is suitable for driving small high-speed steel drills, and its range extends all the way from this class of service up to heavy boring operations, such as enlarging holes in steel and cast iron.



No. 2 "Hi-duty" Drilling Machine built by Minster Machine Co.

The drive is provided by a large single pulley running at constant speed and then through high-carbon steel shafting and heat-treated stub-tooth transmission gearing to the main spindle. An extremely simple gear-box is provided which gives six initial speed changes through sliding gears. Standard ball bearings are used throughout the transmission gear-box, thus giving high efficiency. The transmission gears are flooded with oil which is circulated over the gears by an improved gravity feed system of oiling.

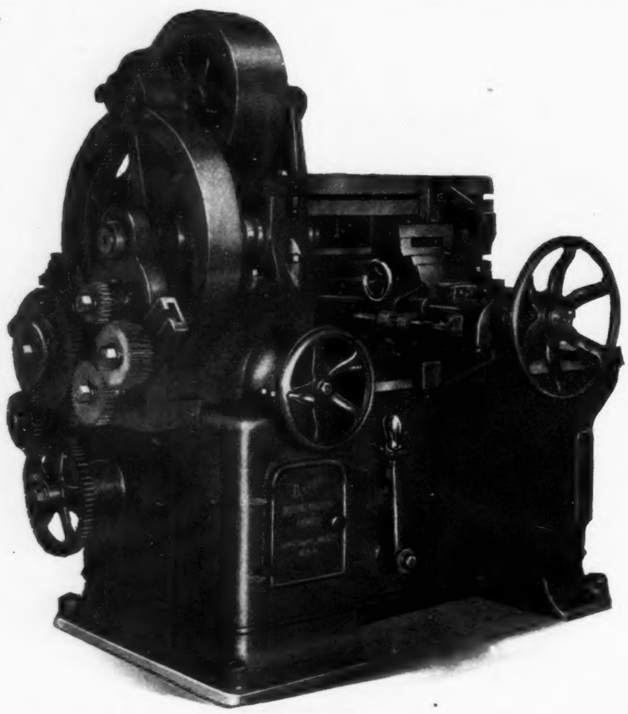
The two cranks engaging holes in dials at the left-hand side of the head provide for obtaining any of the six changes of speed, and the crank above these dials near the front of the head engages the direct drive and back-gears. All of the high speeds are obtained through a smaller gear on the spindle sleeve, thus obviating high tooth velocity, and there are no gears having a tooth velocity of over 800 feet per minute. The lever below the speed dials operates an expanding band friction inside the gear-box which runs in oil to insure proper lubrication. Up and down movement of this lever controls the direction of rotation of the drill spindle and forms a convenient braking device as well as a tapping attachment.

Feed is imparted to the spindle by a vertical shaft seen at the front, and this shaft is arranged to be driven at various speeds by changing the gearing mounted upon a swinging quadrant at the upper end of the spindle sleeve. It is only necessary to change this gearing to suit the feed; twelve regular feeds are provided to take care of all reaming and drilling operations. The steel stub-tooth feed gearing is contained within the feed-box, which is cast integral with the head at the right-hand side of the spindle. The feed gearing is of the sliding gear type and no pull pins are used. The twelve changes of feed are transmitted to a large worm-wheel keyed to the pilot shaft, upon which is cut a coarse wide-faced pinion which engages a wide feed rack that is cross-keyed to the spindle sleeve. The small levers are used for obtaining speed changes, and a suitable index plate indicates the proper position of all levers for both feeds and speeds. An automatic knock-out for the feed gives a positive and accurate depth gage for drilling, and a safety stop prevents the spindle from feeding beyond its proper traverse. Attention is called to the means provided for delivering cutting compound to the drill.

The principal dimensions of this drilling machine are as follows: capacity for drilling holes in steel up to 2½ inches in diameter; distance from center of spindle to face of column, 14 inches; end of spindle to table, 35 inches; end of spindle to base, 50 inches; diameter of spindle sleeve, 4 inches; minimum diameter of spindle, 2¼ inches; Morse taper in spindle, No. 5; width of feed rack, 2 inches; diameter of driving gear, 11 1/3 inches; face width of driving gear, 2½ inches; size of finished surface of table, 20 by 26 inches; vertical adjustment of table, 18 inches; range of feeds, from 0.006 to 0.069 inch per revolution; range of speeds, from 30 to 550 revolutions per minute; size of driving pulley, 20 inches in diameter by 3½ inches face width; driving pulley speed, 550 revolutions per minute; and net weight of machine, 5300 pounds.

BECKER BACKING-OFF MACHINE

For use in relieving form cutters, the Becker Milling Machine Co., Hyde Park, Boston, Mass., is now building a machine which forms the subject of this article. It is adapted for backing off cutters up to 13 inches in diameter having all numbers of flutes from three to twelve, inclusive, and all even numbers of flutes from twelve to forty, inclusive. Hobs and worms can also be cut on this machine, and when giving



Becker Backing-off Machine for relieving Form Cutters

hobs a clearance the cam can be thrown out in reversing. The gearing used in cutting hobs and worms may be easily disconnected when not in use. The machine is designed to give straight or periphery, side and end relief on all classes of cutters that come within its range.

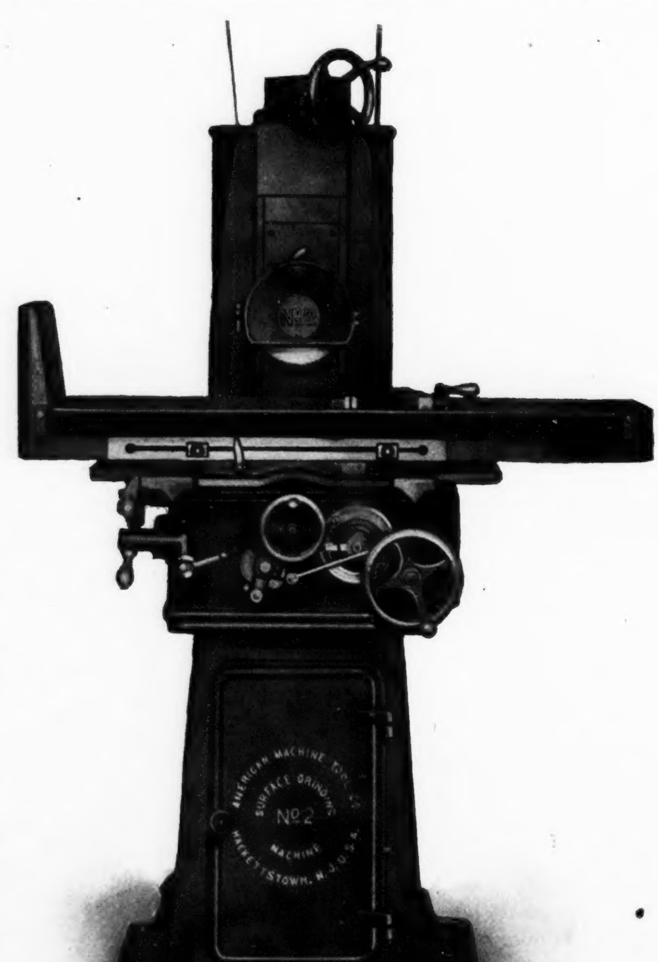
It will be seen that this machine is of the arm type, and alignment of the tailstock is maintained by two T-slots in special ways at the back of the bed. Provision is made for locking the tailstock in any desired position by four clamping bolts, and the maximum adjustment of the tailstock is through a distance of 24 inches. The spindle is made of crucible steel, and has a maximum diameter of 3¾ inches; it is driven through spur gears mounted directly on the spindle. The spindle bearings are of solid phosphor-bronze, and are provided with means of compensating for wear. The taper hole is No. 13 B. & S., and the spindle is bored to accommodate a ¾-inch draw bolt. Clutch drive insures positive rotation of the tool to be relieved. The drive is through a single pulley 14 inches in diameter by 4 inches face width, and three speed changes are provided through simple gearing.

A single-throw cam at the back of the machine provides for giving relief from 0 to ¼ inch, which is ample to meet all requirements; this cam is rigidly held by cam-shaft supports, and wear on the cam rolls may be taken up by tapered gibs to insure a positive throw. Cutters to be formed can be placed in the proper relation to the forming tool without loosening the bolt or nuts, by operating the worm meshing with a worm-wheel on the cam-shaft. A micrometer stop attached to the periphery relief slide provides for accurately resetting the tool after changing the work. Periphery and side relief are obtained by the same cam; end relief is obtained by a separate cam located at the end of the machine. The tailstock is made to take either a collar bearing or center bearing, according to the nature of the work; a collar bearing is used for taking heavy cuts on work supported by a long arbor to insure rigidity due to support provided on the arbor near the work; and a center bearing is employed in cases where a short arbor is used to carry small work.

The tool-holder block is made to hold tools from ¼ to 1 inch thick; it is set on a 30-degree slide plate and operated by a handwheel at the side to raise or lower the tool to the required position. Provision is made for feeding the tool to the work by a differential handwheel, giving accurate control. This differential is used for fine feed, and it is thrown out of engagement to obtain direct or quick adjustment. Longitudinal adjustment is secured by a handwheel operating bevel gears on the carriage screw, which gives a maximum adjustment of 12 inches. Motor drive may be employed, in which case a three-horsepower variable-speed motor is recommended with a speed range of from 500 to 1500 R.P.M. This motor is mounted on a bracket at the back of the machine. The floor space occupied by the machine is 67¾ by 47¾ inches, and the weight of the machine is approximately 6500 pounds.

AMERICAN NO. 2 SURFACE GRINDER

The No. 2 surface grinding machine illustrated and described herewith is a recent product of the American Machine Tool Co., Hackettstown, N. J. This machine has been developed to meet the requirements of tool-room work, and is especially adapted for finishing dies, punches, gages, etc. All belts are enclosed by the box form of construction, which eliminates the use of guards and gives the machine a neat appearance, in addition to protecting the operator. All slides and working surfaces are provided with covers to shield them from grit and dirt. The working parts are accessible, and the handwheels and levers for controlling the various movements are located in positions most natural and convenient for the operator.



No. 2 Surface Grinder built by American Machine Tool Co.

Wheel adjustment is obtained by means of a screw located between the housings, and is actuated by a handwheel graduated to 0.00025 inch. The screw is operated by a pair of spiral gears, which gives a very smooth movement; and both screw and gears are protected from dust and dirt. Provision is made for locking the spindle housing in position by a lever-actuated

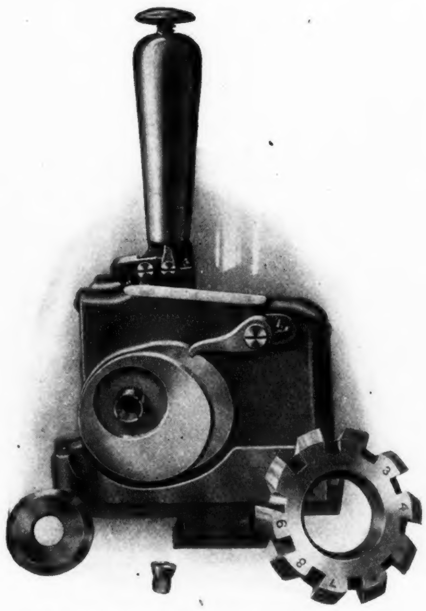


Fig. 1. Parts of Rivett-Dock Thread Cutting Tool

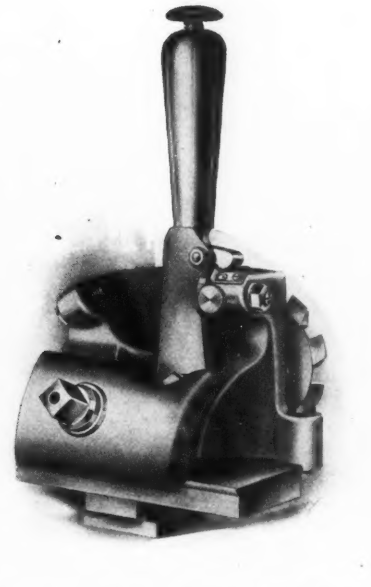


Fig. 2. Rivett-Dock Thread Cutting Tool Assembled

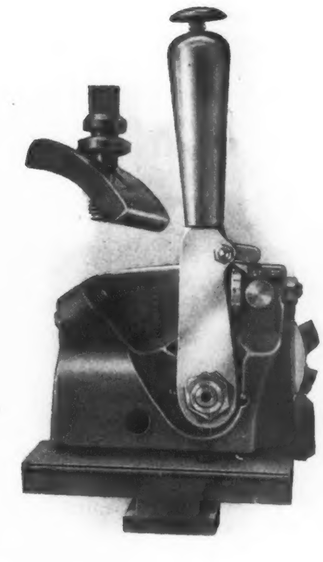


Fig. 3. View of Tool showing Adjustment for Depth of Cut

cam which is positive and rapid in operation. The spindle is hardened, ground and lapped, and runs in tapered split bronze bushings provided with adjustment for taking up lost motion in any direction. The wheel used on this machine is 7 inches in diameter by ½ inch face width. The arrangement of belting to the spindle is very simple; it works on the double-loop principle, providing a liberal amount of belt lap to the pulley.

The mechanism box is cast in one piece and bolted to the main frame in such a way that it may easily be removed for making repairs and adjustments. All mechanism for the various feeds is located in and on this box, and all running shafts in the box have phosphor-bronze bearings which are lubricated from the outside. The table is 46 inches long by 8 inches wide and provided with dust guards which do not interfere with accessibility of the trip mechanism at the front. The working surface is 18 by 6 inches, and has three ½-inch T-slots cut in it. Travel of the table is automatic and is controlled by adjustable dogs operating against a reversing lever. This lever can be turned down and the table moved beyond the reversing point without changing the dogs. Traverse motion of the saddle is automatic, feeding at each reversal of the table in either direction. An adjustable automatic stop is provided which throws out this feed at any desired point, and the traverse feed is from 0 to ⅜ inch at each reversal. By throwing out the automatic traverse feed mechanism, work requiring side grinding can be ground to 0.001 inch by the use of a graduated handwheel. The clutch actuating device in the gear-box is always thrown, regardless of speed momentum.

The countershaft has tight and loose pulleys 8 inches in diameter by 3¼ inches face width, and the driving pulley is 16 inches in diameter by 2¼ inches face width, with a speed of 450 revolutions per minute. The belt shifter provided on this countershaft completely overcomes the tendency of the belt to run on both pulleys due to the weight of the shifter handle. This handle always returns to the vertical position after shifting the belt. Using a 7-inch wheel, this machine will grind work 18 inches long by 6 inches wide by 9 inches high. The regular equipment includes one vise with jaws 4 1/8 inches long by 1 1/16 inch deep with a 2-inch opening, one wheel 7 inches in diameter by 1/2 inch face width, a countershaft, and the necessary wrenches for making all adjustments. The floor space occupied is 30 by 65 inches, and the net weight of the machine, with countershaft, is 1490 pounds.

RIVETT-DOCK THREAD CUTTING TOOL

The Rivett Lathe & Grinder Co., Brighton, Boston, Mass., has redesigned the familiar Rivett-Dock threading tool. In redesigning this tool, the objects sought were more positive indexing of the cutter, minimum amount of travel of the operating lever, and a greater latitude of adjustment of the cutting tool. The illustrations will make clear the design, construction and operation of this tool. It is so arranged that it may be clamped into the tool-block slot on any lathe carriage by first clamping the baseplate in position and then adjusting the tool base on the baseplate.

The principle of this threading tool is the same as that of the old model. The tool consists of a fixture for supporting and indexing the special threading cutter. The cutters are made standard, and a special cutter is required for each pitch of thread. This type of cutter has ten cutting points, equally spaced around the circumference and graduated in lengths by increments of one-tenth the depth of the thread. Thus by starting with the lowest point of the tool and taking the successive cuts with each of the ten points by indexing the cutter after each cut, the thread is completed in ten passes over the work. The advantages of a threading tool of this kind are that the depth of feed for each cut is arbitrarily fixed and requires no judgment on the part of the operator. There is therefore less chance of breaking tool-points, and the resulting threads are more accurate. The cutter is mounted on a short taper arbor; the hole of the cutter proper is ground to an included angle of 28 degrees, and by tightening an expanding stud, a bushing fitting this ground tapered hole binds the cutter to the arbor. The cutter-arbor is hardened and ground all over, and fitted in adjustable bushings.

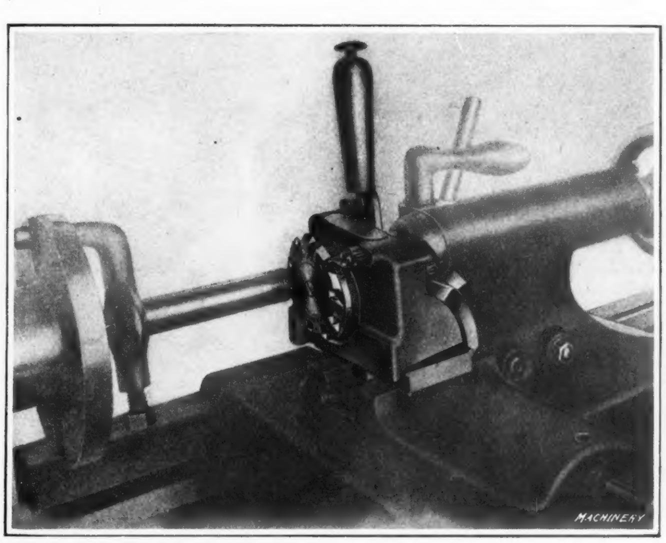


Fig. 4. Thread Cutting Tool in Operation on Lathe

The cutter is mounted eccentrically on the arbor, so that by operating the lever

which turns the cutter-arbor, the cutter is drawn down and back. In the original Rivett-Dock threading tool, withdrawing of the cutter from the work was taken care of by withdrawing the slide on which the cutter was mounted. By employing the eccentric arbor, however, a comparatively shorter movement of the operating handle is necessary for operating the tool. Another point of superiority over the old tool is that the back of the point of the tool coming into operation comes *down* on the supporting stop instead of sliding onto it. The indexing is effected by drawing the operating lever back and pushing it forward toward the work. This allows a gravity pawl to drop in between two of the teeth of the cutter, and the tool is thus indexed on the forward stroke. At the top of the operating handle and working through it is a spring plunger that must be pressed before the handle can be operated. This plunger releases a catch that allows the handle to be drawn back for the indexing movement.

The stop against which this latch catches is adjustable by means of a threaded shank, and it is graduated so that the entire threading tool may be advanced any desired amount from 0.0005 inch up. With the old type threading tool it was necessary to hold the operating lever over while the threading cut was being taken, but with the new tool this is not necessary, as the stop and latch take care of this feature. At the back of the threading tool base is a stop screw that may be set to limit the stroke of the operating handle. This feature takes care of variations in size of different cutters. The entire threading tool housing may be tilted to any desired degree to accommodate the inclination of any pitch of thread.

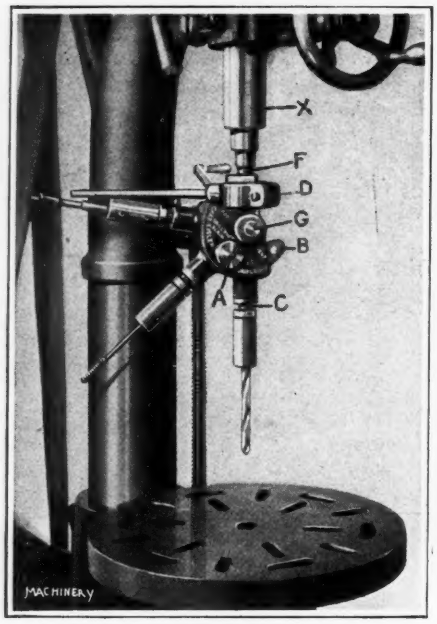


Fig. 1. Eisler Three-spindle Turret Head for Use on Drill Press

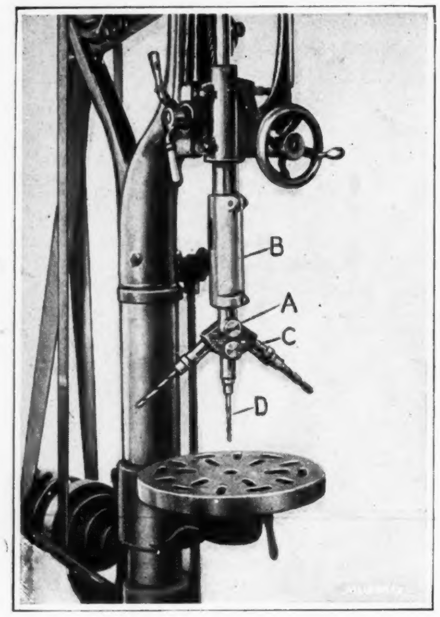


Fig. 2. Eisler Drill Press Turret Head with Sleeve Connection to Spindle

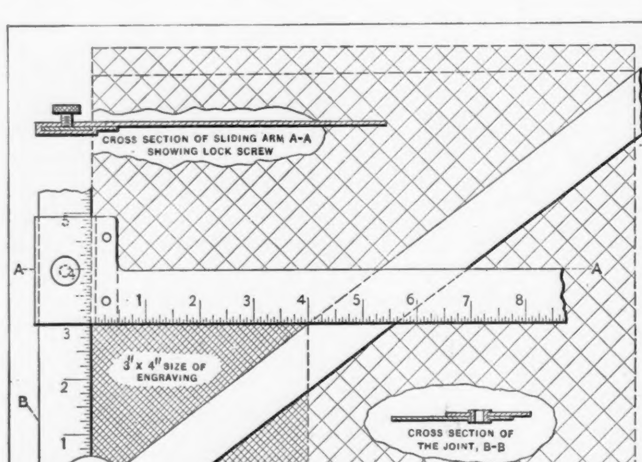
EISLER DRILL PRESS TURRET HEAD

The drill press turret head shown in the accompanying illustrations was developed by Charles Eisler, 43 Dodd St., Bloomfield, N. J., to adapt drilling machines for manufacturing work where there is a sequence of operations to be performed. When there are a large number of parts to be made, saving of time through eliminating the necessity of resetting the work is an important factor that should commend this turret head to favorable consideration. Fig. 1 shows a plain drill press turret head which requires little explanation to make its use readily understood by any mechanic. When the position must be changed, knob *A* is pulled and a plunger automatically locates the next tool in the working position by plunger *A* entering the proper hole *B*. Shank *C* can be made to suit special chucks or with a taper to fit any standard chuck. A stop-rod *D* prevents the body of the tool from rotating. The tools in this turret are driven in the usual manner by a tapered shank *F*, and the body of the head pivots on pin *G*. When spindle *X* is raised, drill spindle *C* immediately stops rotating.

Fig. 2 shows a similar form of turret head except that an automatic stop is provided. When knob *A* is pulled, tool *D* immediately stops rotating without the necessity of raising the drill press spindle. This also shows a sleeve attached to the spindle *B*, which is a desirable feature where the tool is used almost continuously; it is never necessary to stop the drill press when the position of the turret is changed. The turret shown in Fig. 2 is made to accommodate taper shank drills, and in this illustration the drift holes are shown at *C*. The position of the turret head can be changed in one second while the drill press is running. The head is so designed that the operator can change it without being required to leave his working position at the front of the machine. This head is made in several sizes, and different types are made with from two to five spindles. It will be noted that the tool in the operating position is in direct line with the drill press spindle.

MEADWELL PROPORTIONAL MEASURING AND CALCULATING SCALE

At present there are two commonly used methods for solving problems in proportion—one by arithmetic, the other mechanically with the slide-rule. The arithmetical method is sometimes too slow, and many people are unfamiliar with the use of the slide-rule. To facilitate the solving of such problems, and particularly those in which one or more of the members of the proportion contain fractions, W. E. Meadwell, Ithaca, N. Y., developed the proportional measuring and calculating scale illustrated herewith, which affords a simple and accurate method of handling work of this kind. A simple problem in proportion that often arises is to convert the dimensions of a figure of given size to some larger or smaller size, keeping the same relation between the length and width. The Meadwell proportional measuring and calculating scale permits all four dimensions of the two figures to be visualized at the same time; nothing must be remembered, nothing is left to chance, and everything is in plain sight all the time.



Meadwell Proportional Measuring and Calculating Scale for solving Problems in Proportion

This instrument consists of a horizontal sliding arm on which is mounted a lock-screw, and two similar swinging arms held together by an eyelet. The instrument can be made of wood, celluloid, composition, or light metal,

the latter being preferable, as strength is needed as well as a certain amount of flexibility. For solving all mathematical problems such as those confronting draftsmen, engineers and students, these arms are divided into 1000 spaces, but for advertising men, artists, printers and engravers, the scale division would be in inches and fractions of an inch.

The use of the proportional measuring and calculating scale can probably be best explained by carrying through the steps of an actual problem. With the scale having arms divided into 1000 divisions, suppose the following proportion is to be solved:

$$8.73:5.31::3.8:X$$

Stated in plain English, this problem reads: If the long side of a figure 8.73 by 5.31 inches in size were reduced to 3.8 inches, what would be the dimension of the short side of the small figure? To solve this problem, lay the scale on your desk and slide the horizontal arm to the 8.73 mark on the left-hand arm. Then swing the free arm to the 5.31 mark on the horizontal arm. Next slide the horizontal arm down the left arm to the 3.8 mark, without moving the right-hand or swinging arm. The horizontal arm now crosses the diagonal or right swinging arm at the 2.31 mark, which is the required value of X in this problem.

For finding the dimensions of a larger figure, where those of the smaller one are known, the dimensions of the smaller figure are first located within the triangle bounded by the three arms of the instrument. Then, without moving either of the swinging arms, slide the horizontal arm upward on the left arm to the known dimension of the large figure, and this dimension, together with the one obtained by locating the intersection point at the horizontal and swinging arms, will indicate the dimensions of the large figure. The simplicity of this device and the low cost at which it can be manufactured make it an ideal instrument for use in large engraving houses, publishing establishments, advertising agencies, etc. The use of an instrument graduated in inches and fractions would be identical with that already described.

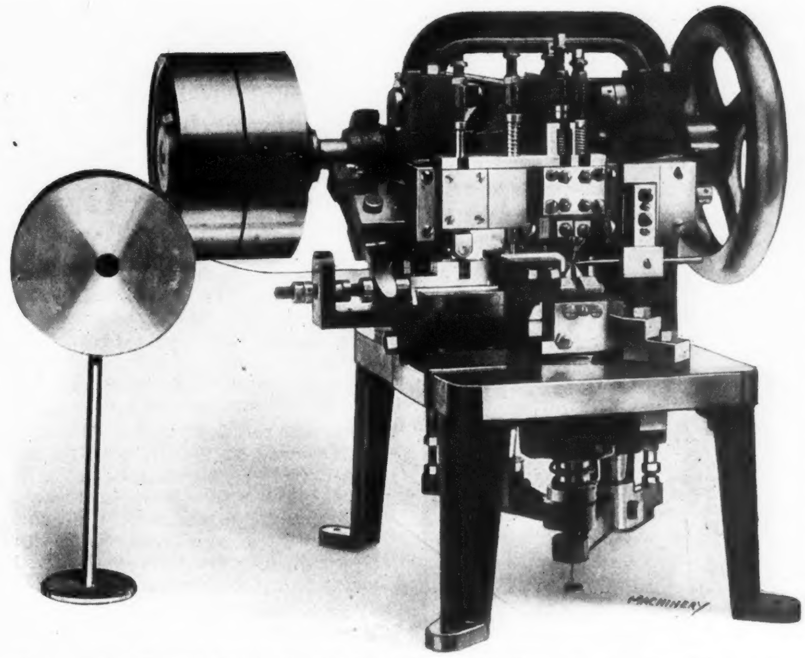


Fig. 1. Front View of Lind Automatic Chain Making Machine, showing Stock Reel and Forming Tools

LIND CHAIN MACHINE

Production of chain has been carried on from the earliest times. All of it was made by hand in the early days, and a great deal of chain is turned out in this way at the present time. Modern fashion, dress and style of living has created a demand for chains made of gold, silver and platinum which have closer and finer links than could be produced by this method. To meet this demand the mechanical engineer was called upon to solve the problem, and as a result of his work it is now possible to procure machines which will make perfect chain so reasonably that chains are now used for a great variety of purposes. These automatic chain making machines have many small and delicate parts in their mechanism, and in order to operate successfully, great care and skill must be exercised in machining, finishing and adjusting these parts.

The J. A. Lind Co., 117 Point St., Providence, R. I., is now building automatic chain making machines in four sizes. The accompanying illustrations Figs. 1 and 2 show the smallest, which is adapted for manufacturing chain from stock ranging from 0.007 inch in diameter with forty-five links per inch up to chain made from stock 0.020 inch in diameter with twenty links per inch, the rate of production being from 120 to 140 links per minute. This is a bench machine which occupies a space of about 18 by 18 inches and weighs approximately 100 pounds. Not over 1/8 horsepower is required for driving it. While having a range for handling four or five sizes, the machine requires great nicety of adjustment in order to operate satisfactorily, and so it has been found good practice to confine each machine to a special size of chain, and this is particularly desirable when a shop has a constant demand for various standard sizes of chain. Insertion of different sets of forming tools of the proper size enables the machine to turn out chain in the several sizes of links within its range. Examples of chain produced on this machine are shown in Fig. 3.

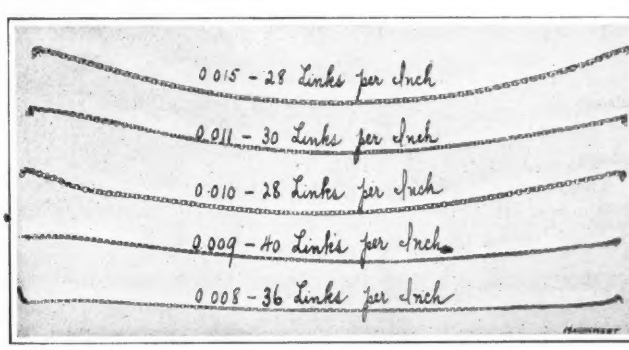


Fig. 3. Examples of Chain produced on Lind Machine

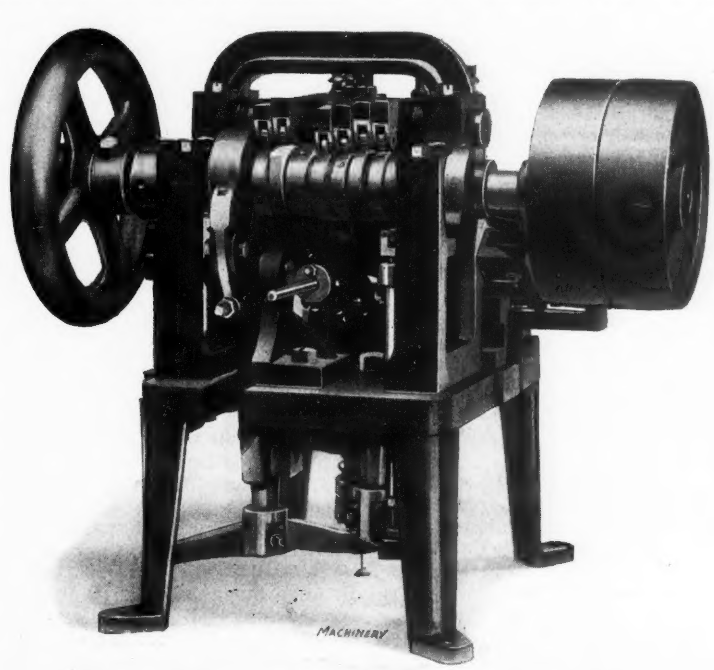
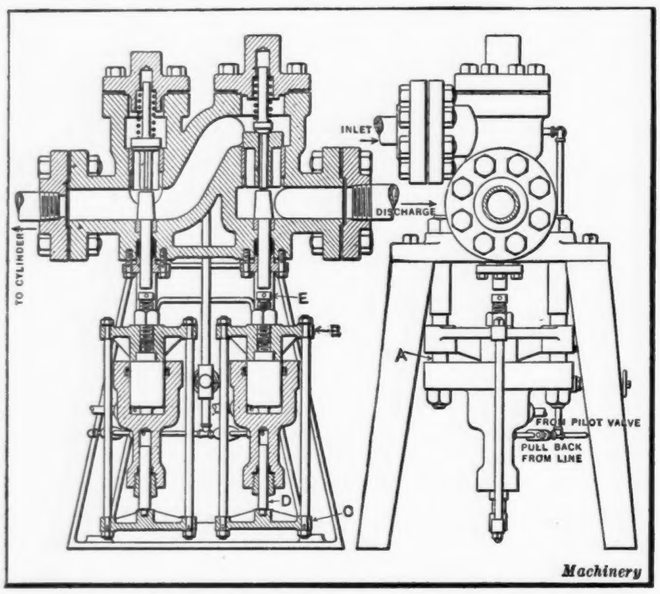


Fig. 2. Opposite Side of Lind Automatic Chain Making Machine

METALWOOD PILOT-OPERATED VALVE

A pilot-operated quick-operating valve with adjustment for speed has recently been placed on the market by the Metalwood Mfg. Co., Leib and Wight Sts., Detroit, Mich. This valve is built in all sizes and for all pressures. For use with water, the valve is constructed with hard bronze valves and seats; and for use with oil, the valves and seats are made of steel. The operating cylinders are suspended from the body by tie-rods *A*, which are provided with shoulders for ram shoe *B*,



Metalwood Pilot-operated Quick-operating Valve with Adjustment for Speed

giving positive stop for the ram. The shoe also carries a yoke to which yoke *C* is attached, which carries pull-back ram *D* under constant pressure. The opening of the valve is adjusted by screw *E*, which is locked in position by means of a jaw nut. The speed of operation of the press is varied by lengthening the screw when the ram shoe is against the column shoulders, which raises the amount of lift on the valves.

NEW MACHINERY AND TOOLS NOTES

Tapping Chuck: Braden Mfg. Co., New York City. This chuck has a reversing mechanism that withdraws the tap when the required depth of hole is reached. A conical friction holding arrangement prevents breakage of taps.

Pneumatic Portable Grinder: William B. Mershon & Co., Saginaw, Mich. While designed for internal work, this grinder is also adapted for center and other classes of grinding. It has a speed of 20,000 revolutions per minute and requires an air pressure of from 50 to 100 pounds.

Toolpost Turret: Universal Machine Works, 311 W. 59th St., New York City. Six stations are provided in this turret for turning tools and six stations for boring tools. The turning tools are carried in swiveling holders, and a special eccentric tool-holder is provided for the cutting-off tool.

Toggle Drawing Press: Toledo Machine & Tool Co., Toledo, Ohio. Toggle drawing and deep stamping presses built in a number of sizes for a wide range of work from small tinware to automobile bodies. The weights range from 6700 to 650,000 pounds. The press can be started or stopped at any part of the stroke with slight effort.

Multiple-spindle Drilling Heads: Nelson-Blank Mfg. Co., Detroit, Mich. The two-spindle head is designed especially for drilling two 3/4-inch holes, 3.82 inches apart, in 9-inch shell plugs, and the heads having three or more spindles are adapted for drilling holes to a predetermined depth, the spindles being provided with vertical adjustment.

Calculator for Drawing Dies: O. H. Jensen, Buffalo, N. Y. A circular slide-rule for determining the maximum reduction in drawing sheet steel with double-action and combination dies, allowing for different thicknesses of stock and diameters of blanks. It is based on the results of exhaustive experiments that were charted and reduced to a slide-rule basis.

Continuous Reading Gage: Industrial Products Co., Chicago, Ill. A gage designed to indicate variations to 0.0001 inch in work being ground. It consists of an Ames gage and mechanism for transmitting to it the horizontal movement of a diamond-pointed rod. The reduction is such that a movement of the diamond through 0.001 inch causes the hand on the dial to move from 0 to 10.

Portable Toolpost Grinder with Extension Spindle: Wisconsin Electric Co., 1402 Dumore Bldg., Racine, Wis. This grinder has an extension spindle for deep internal grinding, lapping out deep drawing dies, etc. The spindle has a reach of 10 inches and is designed to increase the range of the smaller high-speed attachment regularly furnished. Power is transmitted to the spindle through a flexible coupling that eliminates vibration.

Arbor Press: G. T. Eames, Kalamazoo, Mich. Arbor press with swinging tables that permit instant adjustment to suit various sizes and shapes of work. An auxiliary pressure-applying handle moves the ram 5/8 inch per stroke, so that the mandrel is brought into position for the application of greater force by the compound handle, which moves the ram 1/16 inch per stroke. The maximum pressure that can be applied is 30 tons.

Machine for Graduating Fuses: American Ammunition Co., Bordentown, N. J. In this machine, the fuse is held in a draw-in collet, operated by an air chuck; a plunger brought up behind the fuse body prevents its being forced out of the chuck by the pressure of the graduating roll. The machine is driven by a regular punch press releasing gear. The graduating roll is forced into contact with the fuse body by weights working on a bellcrank.

Bench and Column Grinder: Lamb Knitting Machine Co., Chicopee Falls, Mass. The hollow grinder head, which forms a reservoir for the lubricating oil, is secured to the column by three cap-screws, but it may be furnished separately as a bench machine. The wheels are 6 inches in diameter and have a 1-inch face. The steel spindle is 1 1/8 inch in diameter between the self-aligning ball bearings, 7/8 inch in the bearings, and 3/4 inch where it supports the wheels.

Portable Hoist: Ingersoll-Rand Co., 11 Broadway, New York City. This hoist differs from existing types principally in size. The drum is 7 inches in diameter, 17 inches long, and holds 300 feet of 7/8-inch Manilla rope. The hoist is 21 1/2 inches long, 31 1/4 inches wide, and 23 inches high, and the maximum capacity is 600 pounds. It may be operated by steam or compressed air, and is designed primarily for underground work, though it is also suitable, of course, for use in industrial plants.

Spring Nut Lock: Industrial Development Co., Chicago, Ill. A spring nut lock consisting of two hexagonal plates joined at one side. The holes in the plates fit the bolts on which the locks are to be used. Normally, these holes are out of alignment, so that their forced alignment, when the plates are on the bolt, causes the spring connection to exert a strong pulling force on one plate and a pushing force on the other, which gives a tight grip on the bolt thread, and locks the nut securely in place.

Washer Stamping Press: Southwark Foundry & Machine Co., Philadelphia, Pa. A machine which turns out a complete washer at each stroke of the ram, from either scrap or new sheet or plate material. The machine may also be used for different classes of stamping, punching, shearing, etc. If desired, it may be equipped with roller feed for automatically handling washer stock in bands or bars. The plunger has broad wearing surfaces and is fitted with taper gibs to take up wear.

Heavy-duty Manufacturing Lathe: Himoff Machine Co., 128 Mott St., New York City. This lathe is intended for turning projectiles and forgings where the finished diameter does not exceed 9 inches. The bed, which is 8 feet long, is reinforced with box-type cross-ribs, which resist twisting stresses. The headstock spindle is forged from steel containing between 0.50 and 0.60 per cent carbon; a 2 1/4-inch hole extends entirely through it. The tailstock spindle is 3 1/2 inches in diameter and has a 6-inch travel.

Electric Hoist: Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. An electric hoist especially adapted to the requirements of machine tool service. This hoist is built in several sizes for connection with direct- or alternating-current circuits. To provide against overloading, the hoist has been designed with an unusually high factor of safety; and a combination mechanical and electrical brake is furnished, which automatically regulates the braking effect to meet the requirements of the load handled on the hoist.

Riveting Machine: Hanna Engineering Works, 1059 Elston Ave., Chicago, Ill. This machine is designed to operate in places where the space is limited, and is especially suitable for automobile assembling. The toggles, levers and guide links are arranged to give a large opening of the toggle-joint movement, with a gradual increase of pressure. The relatively large distance through which the rated maximum pressure may be exerted makes little adjustment necessary to compensate for variations in the rivet or plate after the machine is set.

Metal-cutting Band Saw: Quality Saw & Tool Works, Springfield, Mass. In this machine a band saw replaces the

short-blade hacksaw generally used, thus giving a continuous stroke. Adjustable guide rollers support the saw both sidewise and against the thrust of the cut. The saw is cooled by contact with the guide wheels, but a lubricant may be used to wash away the chips. As the outer saw wheel is adjustable, saws varying nine inches in length may be used, so that those that are broken before they are worn out may be utilized.

Horizontal Hydraulic Pump: Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. A four-plunger pump that may be equipped with sixteen different sizes of plungers, ranging, by quarter inches, from 1⅜ inch to 5 inches in diameter. The water capacity is from 24 to 326 gallons per minute, and the pressures are from 700 to 9500 pounds per square inch. For the highest pressures, the water cylinders are made of forged steel; for pressures between 1500 and 2900 pounds per square inch, cast steel is used; and for the lowest pressures, semi-steel.

Rotary Pump for Lubricating Machine Tools: Goulds Mfg. Co., Seneca Falls, N. Y. Rotary pumps designed so that they may be used with practically any type of machine tool. These pumps are made reversible for use with screw and automatic machines, in which the direction of rotation is reversed, and non-reversible for machine tools that operate in one direction only. Practically any of the ordinary methods of drive can be employed, while the amount of oil and cutting compound handled is easily controlled by the relief valve and pipes built in the cover.

Shell Threading Lathe: Gisholt Machine Co., 1117 E. Washington Ave., Madison, Wis. A special machine for use in taking the finish-boring and facing cuts, and also for milling threads in the base or nose of shells. It can be adapted for cutting right- or left-hand threads, either internal or external; and the thread may be U. S. standard or metric. This machine enables the boring, facing and threading operations to be performed without transferring the shells from one machine to another, thus saving the time ordinarily required for resetting, and also insuring the production of an accurate thread.

High-speed Ball-bearing Bench Saw: H. G. Crane, Brookline, Mass. A portable, well constructed machine for sawing soft metals, fiber, wood, etc., at a speed of from 1000 to 6000 revolutions per minute. The ball bearings are mounted in dust-proof housings, but can be easily lubricated. The table top may be quickly raised or lowered to any position for slotting and grooving. The motor is hung on a dust chute that is hinged at its upper end; this provides an easy way of keeping the belt in the proper tension. Motors are supplied for 110- and 220-volt alternating and direct current, and of 1/4, 1/3 and 1/2 horsepower.

Back-geared Lathe: Hollingworth Machine Tool Co., Covington, Ky. A machine known as the style H engine lathe which is furnished with three large V-ways and one flat way. The machine is ordinarily equipped with a four-step cone and single back-gears, but double back-gears may be furnished to special order. The machine swings 19 inches over the ways and 12 inches over the carriage; maximum distance between centers for a 6-foot bed is 30 inches; dimensions of spindle bearings are, front, 2¾ by 5 inches, and rear, 2⅜ by 4 inches. The taper attachment for this machine has a capacity for turning tapers up to 19 degrees, or 4 inches per foot.

Internal Grinding Machine: Reno-Kaetker Electric Co., Cincinnati, Ohio. This vertical grinding machine will grind automobile cylinders from 3¼ to 5½ inches in diameter and up to 10¼ inches in length; it can be used also for other classes of internal grinding. The machine has a vertical bar carrying the grinding wheel spindle which is made radially adjustable in order to vary the diameter ground by the wheel. The bar is provided with a circular rack in which a pinion driven by an auxiliary motor engages and provides the up and down feed motion. The emery dust may be drawn out by an exhaust fan, through the exhaust port of the cylinder, or blown out by an attachment furnished with the grinder.

Guard to Prevent Motor Reversal: General Electric Co., Schenectady, N. Y. A device developed for the purpose of guarding against accidental alternating-current motor reversal—especially in cases where motors are installed in connection with elevators, hoists, conveyors, machine tools, etc. This consists of a reverse phase relay which operates on the same principle as a squirrel cage induction motor and is made in both circuit opening and circuit closing types. The operating coils of the relay correspond to the stator of an induction motor, while a hollow aluminum cylinder connected to the contacts corresponds to the rotor. The cylinder does not rotate, but moves either up or down when one of the phases of the line is reversed, this movement causing a toggle to make or break the contact.

Shell-boring Turret Lathes: Reliance Machine Co., Toronto, Ont., Canada. A turret lathe of massive construction, designed for boring 4-inch to 8-inch high-explosive shells. The front headstock bearing is 8½ inches in diameter and 12 inches long, and is fitted with self-oiling rings, as is also the rear spindle. The spindle is made in one piece, with a 15-inch heavy flange to which the chuck is bolted, and is large enough to take the shell inside the bearing. The main driving gear is 4½ inches across the face, and the back-gearing has a ratio of 9 to 1. The thrust of the tool is taken by a special self-adjusting thrust bearing capable of a continuous working load of 8400 pounds. The length of the carriage and the application of power to a steel rack, 3 inches wide and 4 diametral pitch, in the center of the carriage, are relied upon to prevent twisting.

Noiseless Gear: Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Gears made of heavy duck bonded together with bakelite by heating while under heavy pressure. They are said to be as strong as cast iron and unaffected by atmospheric changes. The tensile strength of this material, parallel to the laminations, is 10,000 pounds per square inch; the compressive strength, perpendicular to the laminations, is 30,000 pounds per square inch; and parallel to the laminations, 17,000 pounds per square inch. The material weighs 0.05 pound per cubic inch, has a specific gravity of 1.4 and has a water absorption, by weight, of 0.25 to 2 per cent, depending on the relative amount of edge surface exposed. These gears may be machined in any direction and drilled and tapped readily. The teeth are cut with the same tools as are employed for cutting steel, but the cutting speed is 25 per cent greater and the feed is increased 50 per cent. In most cases, neither housings nor bushings are required; though, where the diameter of the gear is several times the width of the face, end plates may be advisable.

* * *

ROTARY ENGINES

Thousands of misguided inventors have spent their time and money developing inventions of rotary steam engines, but so far as we know there is not a successful rotary steam engine on the market today. In view of all the thought and energy that has been expended on the problem, this seems strange, until one has given the matter careful analysis. The rotary engine apparently has one advantage over the reciprocating engine—the absence of reciprocating parts, which in any machinery are disturbing elements. They eat up energy when run at high speed and cause serious vibration and rapid deterioration. It seems, then, that a prime mover in which these disturbing elements are absent would be superior to one having reciprocating and oscillating parts. While this is true, the fact is that the rotary engine has a number of disadvantages far more serious than this.

It is a matter of extreme difficulty to make a steam-tight joint between moving parts of any except circular shape. A bored cylinder fitted with a piston containing expanding rings may be made practically steam-tight, but it may be safely asserted that in practically no design of rotary steam engine has it been found possible to fit the moving parts so closely that they would be steam-tight without causing tremendous frictional resistance. The advantage of the rotary steam engine of the ideal type is absence of reciprocating parts. Against that single advantage may be placed the following disadvantages, which we have arranged in the logical order leading up to the greatest one—wastefulness:

1. Difficulty of making moving parts steam-tight.
2. Excessive internal friction and resistance.
3. Steam leakage.
4. Excessive steam consumption.

Excessive steam consumption is due to the inherent defects of design. It is quite feasible to provide for cut-off in the stroke of a rotary piston, the same as in a reciprocating piston, and the same economy would result were it not for leakage and friction.

In view of the inherent defects of the rotary steam engine, it seems little less than madness to attempt to develop a rotary gas engine. In the rotary gas engine the difficulties of securing gas tightness are greatly increased. The inventor has to cope also with high temperature and great differences in temperature at the beginning and end of the working stroke.

* * *

A rolling mill recently installed by the Lukens Iron & Steel Co., Coatesville, Pa., is capable of producing finished plates 192 inches wide. These plates are the largest that it is possible to transport with the present loading railway gage. The rolls are 204 inches long by 34 inches in diameter. The largest mill in Continental Europe is said to be that at Witkowitz, in Hungary, which has 178-inch rolls; and the largest in Great Britain are the 168-inch rolls at Dalzell's steel works.

EFFECT OF THE WAR ON METAL PRICES

PRICES AT BEGINNING OF WAR AND NOW AND EFFECT ON FOREIGN TRADE

WHILE the prices of iron and steel have risen rapidly during the past few months, at the beginning of this year few were greater than had been obtained some time in the past twenty years. Yet these prices have not decreased the demand for American goods in other lands, though they have caused a revival in all lines pertaining to the iron and steel industry all over the world. Mines, mills and factories have been more efficiently worked in order that the greatest production may be obtained. As a result of improvements made in the mining methods, the mines of Caen, Normandy, which back in 1900 produced only 142,000 metric tons, are now producing 1,000,000 metric tons annually; and the estimated production of the Katanga copper mines in Belgian Congo will be nearly double that of last year and about two and one-half times that of the year before. New deposits are being worked and new sources of supply are being sought. This fact is shown most forcibly in the case of 80 per cent ferro-manganese. Before the outbreak of the war this metal was supplied almost entirely through British channels at from $35 to $40 a ton. At the beginning of 1915 the price was advanced to $68, but by January, 1916, it could not be obtained for less than $125. In April, May, June and August of this year, it sold for $175 a ton, and it was reported that some small lots had been sold for $185 a ton. But these prices and the conditions demanded by the British agents caused many manufacturers to work known American deposits and also to buy foreign ore, which is smelted in American furnaces. Much of this ore comes from Brazil, where American corporations have secured control of large ore deposits.

Germany, since the outbreak of the war, has obtained its ferro-manganese by mining the deposits at Ilseder-hütte, near Peine, east of Hanover. As this lay beneath the village of Ilsede, it could not be mined; but when the nation was cut off from its accustomed sources of supply the village was removed and these deposits developed. Recent reports from Dutch sources, however, say that the supply of manganese is small, so that, together with a lack of skilled workmen in the mills, German iron is deteriorating in quality.

Pig Iron, Billets, Plates and Beams

The accompanying table gives the average prices of iron and steel, in various forms, copper, tin and lead for the past eleven months, together with prices for December, 1915, and the highest prices, in most cases, for twenty years. In November, when Bessemer pig iron sold for $30.95 a ton, it surpassed its previous high record price, which was made in January, 1900. During the years that have passed since that price was obtained, the price of this iron has fluctuated greatly, but has been above $20 only during part of 1902 and 1903 and the last quarter of 1906 and most of 1907. The outbreak of the war found this metal selling for $14.90, and its price did not begin its present upward trend until the fall of 1915. Basic pig iron reached its pre-war record price in May, 1907, when it sold for $22.90 in Pittsburg. In both January and December, 1914, it sold for $12.50 a ton, and did not begin its rapid increase in price until August, 1915, when its price jumped from $12.75 to $14.06. Still, the exports of pig iron this year were greater than ever. During the eight months ending August 31, 1916, over 238,300 tons were sent abroad, compared with 127,700 tons in 1915 and 83,700 the year before. The value of this year's exports was $5,946,000.

Bessemer steel billets established a record price last March when they sold for $40.60 and, as shown in the table, they have been making a new record each month since; $60 a ton was quoted in November. Since March they have been on a parity with open-hearth billets. The previous record price for Bessemer billets was made in September, 1899, when they sold for $38.87; the price fell to $16.50 during the next year. It again passed the $20 mark the following February, and was sold for less than that only during the four months before June, 1914. In December, 1914, Bessemer steel billets brought only $19 a ton in Pittsburg, but the following fall the price was raised so rapidly that the year closed with these billets selling for $30.60 a ton. During the first eight months of this year, the value of our exports of billets, ingots and blooms of steel was $49,335,790, against $7,773,290 in the same period last year and $694,050 in 1914. This increased value of exports is due both to the increase in the amount of goods shipped, 895,000 tons in 1916 against 353,000 tons in 1915, and the great increase in price. Nearly three-fourths of these exports, or 632,700 tons, valued at $36,365,600, were sent to France, while 116,416 tons were sent to Great Britain and 63,970 tons to Canada. During the same period our imports of billets, etc., amounted to 8200 tons, as compared with 1700 tons in 1914 and 1100 tons in 1915.

Because of the great increase in the price of billets, in April the fifteen-year-old price of Bessemer steel rails was abandoned and $33 a ton was demanded for all rails delivered after May 1, 1917. The price of open-hearth rails was raised, at the same time, to $35. In November, because of the continued increase in the price of billets, these prices were again raised to $38 and $40 a ton.

The revival of ship-building is shown in the prices of plates. These reached their lowest price March, 1898, when they sold for 0.97 cent a pound. Their high record price was made in September of the following year, when it reached 2.85 cents. Since then the average price has been about 1.6 cent, though in January, 1914, they brought only 1.2 cent in Pittsburg, and in December only 1.05 cent. A year later, however, they sold for 2.04 cents a pound, and this year they have steadily in-

COMPARATIVE PRICES OF IRON, STEEL, COPPER, TIN AND LEAD

	1915 Dec.	1916 Jan.	Feb.	March	April	May	June	July	August	Sep.	Oct.	Nov.	Former Record Price
Ferro-manganese, dollars per ton	100	125	140	150	175	175	175	172.50	175	164	162	164	65
Bessemer pig iron, dollars per ton	19.85	21.32	21.45	21.55	21.95	21.95	21.95	21.95	21.95	22.20	24.32	28.45	24.90
Basic pig iron, dollars per ton	18.55	19.20	18.77	19.20	19.20	18.95	18.95	18.95	18.95	19.075	20.82	24.95	22.90
No. 2 Foundry pig iron, dollars per ton	18.55	19.95	19.51	19.45	19.45	19.325	19.45	19.45	19.45	19.50	21.075	26.40	26.85
Lake Superior charcoal iron, dollars per ton	19.15	19.25	19.50	19.75	19.75	19.75	19.75	19.75	19.75	19.75	20.35	25.75	....
Malleable Bessemer iron, dollars per ton	18.10	19.00	19.00	19.20	19.50	19.20	19.50	19.50	19.50	19.15	19.50	25.00	....
Bessemer billets, dollars per ton	30.80	33.75	34.00	40.60	45.00	44.25	41.20	40.00	43.60	45.00	45.75	55.00	38.87
Open-hearth billets, dollars per ton	30.20	34.75	35.00	40.60	45.00	44.25	41.20	40.00	43.60	45.00	45.75	55.00	....
Bessemer steel rails, dollars per ton	28.00	28.00	28.00	28.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	38.00	32.29
Beams, cents per pound	1.74	1.865	2.03	2.40	2.50	2.50	2.50	2.50	2.50	2.60	2.70	2.80	2.25
Tank plates, cents per pound	1.74	1.875	2.13	2.50	2.67	2.75	2.75	2.86	2.90	2.95	3.00	3.25	2.85
Sheets, black, No. 28, cents per pound	2.54	2.58	2.60	2.75	2.91	2.92	2.92	2.90	2.75	2.88	3.22	3.75	3.77
Wire nails, dollars per keg of 100 pounds	2.22	2.12	2.22	2.38	2.40	2.50	2.50	2.50	2.59	2.60	2.62	2.85	3.20
Heavy melting steel scrap, dollars per ton	17.40	17.50	17.37	17.95	18.12	17.12	16.25	16.25	16.00	16.12	17.87	19.25	22.00
Copper, cents per pound	20.24	24.00	26.68	27.12	28.75	28.85	27.81	20.87	26.90	28.00	28.55	29.50	24.62
Tin, cents per pound	38.53	42.09	41.80	50.15	50.37	49.25	41.81	38.15	38.48	38.56	41.17	42.25	50.34
Lead, cents per pound	5.33	5.85	6.19	7.06	7.62	7.46	6.81	6.43	6.23	6.87	7.00	7.00	6.31

Machinery

creased in value until 3.25 cents was reached in November. Beams have had a like experience, but have usually lagged a little behind. They did not reach their highest price until December, 1899, when they sold for 2.25 cents a pound. While they sold for 1.2 cent a pound at the beginning of 1914, at the close they could be obtained for 1.07 cent. A year later they were worth 1.74 cent a pound, and last November could not be obtained for less than 2.8 cents. Both plates and beams have been in great demand at home and abroad, large orders having been placed for delivery this coming year. During the first eight months of this year our exports of sheets and plates amounted to 730,983,000 pounds; 120,000,000 pounds more than in the same period of 1915 and nearly twice as much as in 1914. The value of these shipments increased from a little over $12,000,000 in 1915 to over $20,000,000 this year. Each year Canada was the best market, taking, this year, over 341,000,000 pounds; Japan was the second, having purchased over 114,000,000 pounds.

Nails and Scrap

So far, the record price of wire nails has not been surpassed; this is $3.20 for a keg of 100 pounds, which was obtained during the first three months of 1900. Wire nails were selling for $1.52 when the war began, but were not affected by the upward trend of prices until December of the following year, when they sold for $2.04 a keg. Last November they had reached $2.85 a keg. This rise in price is partly explained by the exportation of 222,524,850 pounds during the first eight months of this year, against 127,706,950 pounds in the same period last year and 43,341,100 pounds in 1914. The total value of the nails, spikes, tacks, etc., that were exported in the first eight months of this year was over $8,660,790, against a little over $3,566,000 for the same period last year.

While the exports of scrap and old iron and steel increased four-fold in the first eight months of this year over the exports of the same period for the last two years, the price of heavy melting scrap did not reach $22 a gross ton, which was paid for it in November, 1899, until the middle of November, when $25 was offered for it. In fact, until September, 1915, the prices of scrap were especially low. In November, 1914, the price of heavy melting scrap reached its lowest point in many years; it was then sold for $9.25 a ton. The 41,430 tons of scrap imported during the first eight months of this year had a value of $525,980, or about $12.80 a ton, while the 121,833 tons of scrap sold abroad had a value of $2,040,471, or $16.87 a ton.

Copper, Lead and Tin

Considerable attention has been drawn to copper by the recent inquiry for prices for 200,000,000 pounds by France, although that country is sharing with Great Britain and the other allied governments in the 448,000,000 pounds purchased during the summer months. Besides, American producers sold 400,000,000 pounds to the Allies in the first half of this year. As the domestic consumption of copper in October was 150,000,000 pounds, experts say that 2,000,000,000 pounds will not meet the demands next year, even with Germany out of the market. During November, it was said that several carloads had been sold for 32.25 cents a pound, though the regular price was 29.5 cents. In January, 1907, copper sold for 24.41 cents a pound. Except for a few months before and after that time, it did not sell for over 20 cents a pound until last December. During 1914 it steadily decreased in value until 11.73 cents was reached in October, which was the lowest price in twelve years.

In the first eight months of this year there were imported 422,820 gross tons of copper ore, matte, concentrates, etc., which gave 122,353,595 pounds of the metal. Of this, 26,655,300 pounds came from Canada, 21,285,500 pounds from Mexico, 29,349,275 pounds from Cuba, and 32,957,900 pounds from Chile. In the form of bars, pigs, plates, clippings, etc., there were imported 204,095,000 pounds. The value of all the imports during the first eight months of this year was $65,656,500. There were exported in various forms in this period, which was before any part of the large order for the allied governments was filled, 522,131,230 pounds, a decrease of 100,000,000 pounds over the same period in 1914, but an increase of 66 per cent in value.

Lead, too, has reached prices heretofore unknown, selling for 8 cents a pound during the third week of March. Selling for 4.11 cents in January, 1914, it gradually fell to 3.52 cents in October, which is the lowest it has been in twenty years. Beginning, then, its upward climb, it passed in March its previous high mark of 6.31 cents, reached in February, 1907. The imports during the first eight months of this year were but a little more than one-half that brought into the country during the same period of 1915. This was due to the conditions existing in Mexico, as the imports from that country were reduced over one-half. There were exported 126,334,370 pounds of bars, pigs, etc., an increase of only 6,340,000 pounds, but the value was over 60 per cent greater.

Tin reached its highest value in April, when it sold for 50.37 cents a pound; its previous high price was 50.34 cents, obtained in January, 1913. During the past three years, though, its price has fluctuated greatly. In one case it lost 18 cents in two months. In the first week of January, it was selling for 44 cents a pound, but its average price for the month was only 42.09 cents. It then quickly jumped to its highest point, and in September had dropped down to 38.56 cents again. In November, 42.25 cents was the selling price. There were imported into the country in the first eight months of the year 104,462,790 pounds of bars, pigs, plates, etc., and 14,794,500 pounds of ore and scrap. The amount exported was small. During this year a smelter has been opened at Perth Amboy, which obtains tin from Bolivian ores. D. E. J.

* * *

WOMEN AND GIRLS IN MACHINE SHOPS

As is well known, women and girls have been employed in the machine shops of Europe to a large extent since the outbreak of the war, on account of the need of the men at the front. The *Travelers' Standard* states that this change in industrial conditions has made it necessary to revise certain of the rules and regulations prevailing in such shops for the guidance of the employes. Following is a list of special rules that have been adopted by the Iron Trades Employers' Insurance Association, Ltd., of Scotland, for use in machine shops in which women are employed:

NOTICE

Employment of Women and Girls

1. No female worker shall be allowed to be in machine shops unless her hair is tightly done up, well secured, and confined by a tight-fitting cap of close net or of some other suitable and efficient material.
2. Further, she must wear a close-fitting overall completely covering the dress—the said overall to fasten at side or back and to include sleeves buttoned or otherwise secured at their ends.
3. Any machinist found trying a gage while her machine is running will be liable to instant dismissal.
4. Belts must be changed by a male supervisor, or a man specially appointed for that purpose, and not by the ordinary operative.
5. Machines must not be cleaned under any circumstances whatever while running.
6. No guards shall be removed from any machine without authority from the supervisor, and such guards are to be replaced and the machine inspected and passed by the supervisor before a re-start is made.

* * *

NATIONAL-ACME MFG. CO.'S INCREASE OF CAPITAL STOCK

An eastern banking firm has agreed to purchase the stock of the National-Acme Mfg. Co. of Cleveland, Ohio. The syndicate will pay $150 cash and five shares of stock, par value $50, in a company of similar name to be organized, for each of the present shares of the company. The National-Acme Mfg. Co., which builds multiple-spindle and single-spindle screw machines and manufactures machine screws, etc., has plants in Windsor, Vt., Cleveland and Montreal. It has just redeemed the issue of $1,500,000 preferred stock, and has outstanding $5,000,000 common stock. It is expected that the new company will be capitalized at $25,000,000.

LAYING OUT CHORDS OF CIRCLES

BY GUS LUCK[1]

In the shop where the writer is employed, it is frequently necessary to lay out bolt holes on circles of a number of different radii and for a great variety of spacing between the centers of adjacent bolts. The old, inefficient cut-and-try method of obtaining the required spacing for a circle of given radius, and for a given distance between the centers of adjacent bolts, was a source of constant annoyance and loss of time, which was only partially relieved by tables drawn up to give the exact chord required for the cases most frequently encountered. To avoid trouble of this kind, I developed a laying-out device which has given very satisfactory results. Reference to Figs. 1 and 2 will show that it consists of three graduated bars which are pivoted together. The two side bars are laid off in thirty-seconds of an inch for circles of various radii, while the third bar is graduated for different numbers of divisions into which it is required to divide a circle. In use, the runners *A* on the side bars are first set for the required radius of circle; then the sliding clamp *B* on the base is run along to the graduation which represents the required number of divisions in the circle, after which the clamp is tightened. The trammel points are set on the center-punch marks on the runners on the side arms, which gives the required spacing, and the circle is divided up in the usual way.

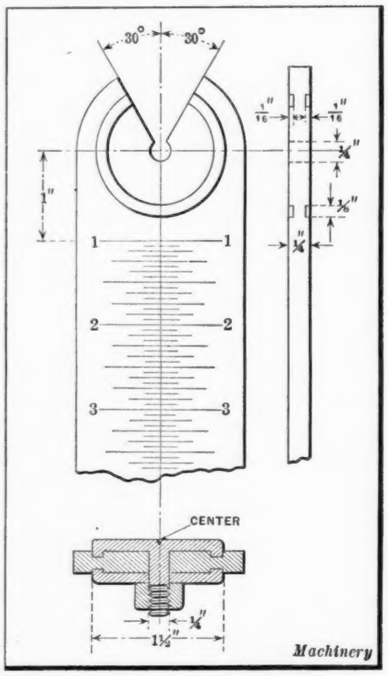


Fig. 3. Plan and Cross-section of Radius Arm Hinge

This spacing device is somewhat similar to a spider's web, from which I got the idea which led to its development. The two side arms which are graduated for different radii are pivoted together by a special hinge of the form shown in Fig. 3. To lay out the chord bar, the runners on the side arms are set at their maximum position of 10 inches. The points of the trammels are set exactly 10 inches apart, and the side arms are then spread sufficiently so that these points will enter the center-punch marks on the runners. When this setting has been obtained, the clamp on the chord bar is tightened to secure the instrument in place. It will be evident that under these conditions the included angle between the side bars is 60 degrees, and that the tram bar is set to divide the circumference of a circle of 10-inch radius into six equal spaces. Consequently, a line is scribed against runner *B* on the chord bar and this is marked 6.

For obtaining other numbers of divisions, the method of procedure is as follows: The circle of 10-inch radius is laid out and points on the tram bar are set to divide this circle into the required number of spaces; then the tram points are set in the center-punch marks on the runners on the side arms, after which the clamp of the chord bar is tightened and a line is drawn for that number of spaces.

[1] Address: 1140 National Ave., Milwaukee, Wis.

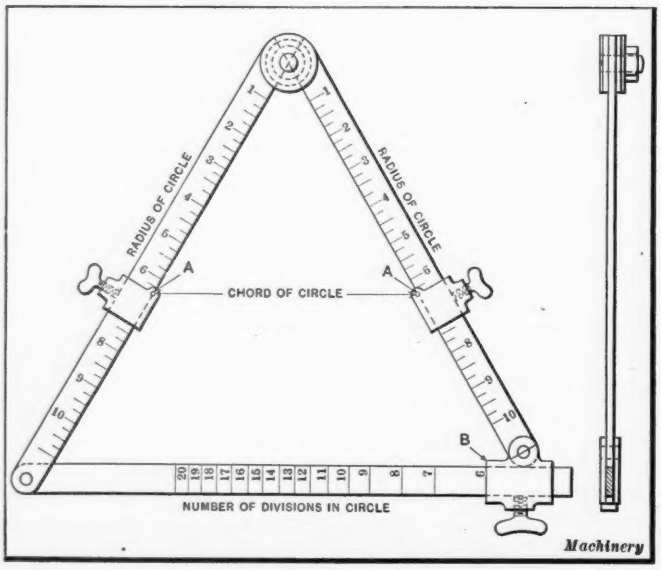


Fig. 1. Device for obtaining Chords of a Circle for Various Numbers of Spaces

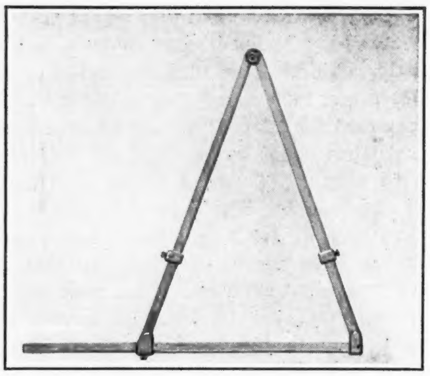


Fig. 2. Another View of Chord Setting Device

The required distance between the tram points for any number of divisions may be calculated as follows: Let N = number of spaces required and a = one-half the included angle for this number of spaces.

$$a = 180 \div N$$

$$\text{Required chord} = \sin a \times 2R$$

In order to explain the method, we will carry through the calculation for determining the chord for seven spaces. In this case, $N = 7$, $R = 10$ inches, and $a = \frac{180}{7} =$ 25 degrees, 43 minutes.

Sin 25 degrees, 43 minutes = 0.43392.

Required chord = 0.43392 × 20 = 8.6784 inches.

It would be obviously impossible to set the trammel points accurately to four decimal places, but this calculation enables the approximate setting to be obtained more rapidly than by a cut-and-try method, and then the final adjustment may be made until exactly the required spacing is obtained.

When this instrument is used by patternmakers, the trammel points are set by a shrink rule to the required radius. Then one point is placed on the hinge center and the runners on the side bars are set to the other point. The chord that will give the required spacing is then obtained in the manner previously described.

* * *

GREAT BRITAIN FAVORS DECIMAL SYSTEMS?

The Department of Commerce has been officially advised that the British government is considering the adoption of a uniform decimal system of weights, measures and currency, instead of the cumbersome systems now in use. At a recent meeting of the British Imperial Council of Commerce, which was attended by representatives from practically all the commercial organizations of the empire, it was decided to investigate trade conditions that would be affected by the change and also to create sentiment in favor of the change in Australia, Canada and all the British provinces. Those advocating the change claim that not only should the system of measurements be uniform throughout the empire, but that the old systems would be a handicap to the efforts to hold and increase British commerce at the close of the war, while the decimal systems would be a great advantage at that time.

* * *

The navy department will open bids December 6 for four battle cruisers, which are intended to be the most powerful of all armed cruisers. They will be 850 feet long and have a displacement of 35,000 tons. The speed required will be between 32 and 35 knots and the propelling engines will develop about 180,000 horsepower. The vessels will carry ten 14-inch guns, and will cost $20,500,000 each.

NOTES ON THE INSPECTION OF BRONZE AND BRASS[1]

Brass and bronze castings are subject to various defects that are difficult to discover by surface inspection, or even by hydrostatic testing, when such a test is practicable. The most common defect results from the inclusion of oxide in the metal of the casting. When the molten metal contains an admixture of oxides, owing to insufficient protection from the air, the entire casting is bad. The best way to discover this defect is to make tensile tests on specimens cut from a coupon cast from the same melt, as the admixture of oxide is indicated by the greatly reduced elongation and the low ultimate strength. If a tensile test is impracticable, the presence of oxide will be indicated, when a machined piece is bent, by a number of small cracks which open on the outside of the bend; if the oxidation is extreme, the surface of the fracture will also have an abnormal color.

Oxidation of metal in the crucible is a very common defect, especially in the mixtures containing a high percentage of copper; that is, the bronzes. It is the writer's belief that in foundries where tensile or hydrostatic tests are not made, the metal is in many cases allowed to become seriously oxidized in the crucible, because this defect does not show on the surface of the casting. To specify bronze castings merely by the mixture is therefore useless; the proportion of one or two of the ingredients may be decreased by oxidation. A bronze casting may be made of the correct mixture, and may show no surface indications of defects, and still be a honeycomb of metal filled with oxides.

The presence of included dross is more difficult to discover if a hydrostatic test cannot be made, and this test does not always reveal such defects. The best insurance against this defect is correct molding—a thing which, strange to say, is very unusual. This fault, however, cannot be charged entirely to the foundryman; the designer is often equally to blame. The various parts of the casting should be so arranged that they are connected by a rising channel of increasing cross-section and with a minimum of offsets to one of the risers, which should be of much greater diameter than the thickest part of the casting. Chills may be used to some extent as a substitute for this arrangement, but only when a channel of increasing dimensions is impracticable, and then only to a limited extent.

Whenever practicable, castings should be poured from the bottom. While some castings cannot be poured from the bottom, it is a question whether those poured from the top are ever entirely free from dross. In determining the position of the casting in the mold, extensive flat upper surfaces should be avoided, as dross may accumulate by being caught under the flat surfaces of the mold or core. When a flange forms the upper surface of the casting, it should be expected to contain some dross, and an adequate amount of finish should be allowed so that this dross will be entirely removed in machining.

Another source of trouble is insufficient risers. A casting may be made in accordance with the drawings and specifications, and yet contain deposits of dross which may cause it to fail under ordinary working conditions; still these defects may be such that they would not be discovered by the most careful inspection or by a hydrostatic test. In specifying brass or bronze castings the total cross-section of the risers should be given in per cent of the greatest horizontal cross-section of the casting.

Minor leaks in hydraulic casting may be stopped by peening, but the fact that the casting leaks at a certain point generally indicates that the metal is defective at this point. The belief that certain brass and bronze mixtures are normally porous and permit water to pass through them under high pressure is erroneous, at least up to a pressure of 1000 pounds per square inch. If water comes through the walls of a casting, even in minute quantities, under smaller pressures, the metal is not clean or the casting is porous from some other condition.

If the defect is small and other circumstances permit, a hole may be drilled and a plug of the same metal as the casting may be screwed in. If plugging is not practicable or permissible, defective spots should be cut out by chipping or drilling so that all the defective metal is removed. The cavity may then be filled by melting metal into it from a rod by means of a gas flame, or by pouring metal into it from a crucible. When a defective spot in a casting is welded, the cooling of the metal in the weld will be accompanied by contraction which will put a tensile stress in the metal of the weld as well as in the old metal which surrounds it. If the casting is of small lateral dimension, the ends are not constrained, and the break extends all the way across it, the stress set up in the old metal by the shrinkage of the weld is compressive, and there is therefore no danger of cracking. In all other cases, shrinkage stress must be prevented by keeping the casting heated to a very high temperature while the weld is being made and until it has solidified.

Another way to prevent cracking is to anneal the casting immediately after the weld has been made. There is no reason to believe that the metal surrounding the weld is injured by the shrinkage stress until corrosion occurs on its surface. Therefore, if the elastic limit of the metal surrounding the weld is lowered by heating the entire casting to a sufficiently high temperature, additional flow will occur, and the cooling stress will thus be gradually reduced to a minimum according to the length of time the annealing is continued. The annealing temperature should be maintained for several hours, so as to give the metal time to flow. Repairs of this kind should, of course, be made before any machining has been done, because the dimension of the casting may be appreciably affected by the shrinkage in the weld as well as by annealing. Castings which are subject to hydrostatic test should be given a preliminary test before any machining is done. A pressure of 100 pounds, or even less, will generally be sufficient to reveal defects.

In machining brass and bronze castings, trouble frequently arises from the fact that the patternmaker did not make proper allowance for minimum shrinkage. When a brass or bronze casting is constrained, shrinkage in the constrained direction is generally much less than normal shrinkage. Core or other inside dimensions, which are tied up with outside machining dimensions, should therefore not be laid out on the pattern with a shrinkage rule, but with a normal rule. The designer can aid in preventing errors of this kind by marking over-all machining dimensions of castings "Must be exact," when it is really necessary that they should be exact.

When a rod, bar, tube, or shape of brass is pulled through a die, the permanent reduction is proportionately greater at and near the surface than in the interior. The stress thus set up in the surface of drawn brass frequently exceeds the initial elastic limit, and cracking may therefore be expected when corrosion takes place. This is the reason that this defect is called "season cracking." Drawn material should therefore be immediately treated in some way to relieve the stress. This may be done by stretching the metal near the surface mechanically or by temporarily reducing its elastic limit by heating, and thus allowing it to be stretched by the compressive stress in the interior metal. It can also be done by annealing. Merica and Woodward, in a paper read before the American Institute of Metals in 1915, stated that if sufficient time is allowed for annealing, so that the metal is given ample opportunity to flow, the temperature need not be as high as it would have to be in order to eliminate initial stress by a quick annealing. The presence of initial stress in wrought brass may be detected most quickly by cutting a longitudinal slit in the end of the piece. If the initial stress is of sufficient magnitude to be objectionable, the halves of the piece will curve out to a measurable degree.

Extruded brass rods are sometimes subject to a hidden defect, namely, piping. Such rods are generally cut to length by sawing, but if the pipe is small, it will be hidden by the rubbing of the saw. The presence of this defect may be discovered by nicking the end of the rod and breaking it off.

Because brass must not be kept under stress greater than its initial elastic limit and equal to its acquired elastic limit for any considerable length of time, brass and bronze should be regarded as generally unsuitable for bolts and studs. It

[1] Abstract of a paper by Ernst Jonson read at the annual meeting of the American Institute of Metals, September 11-15, 1916, at Cleveland, Ohio.

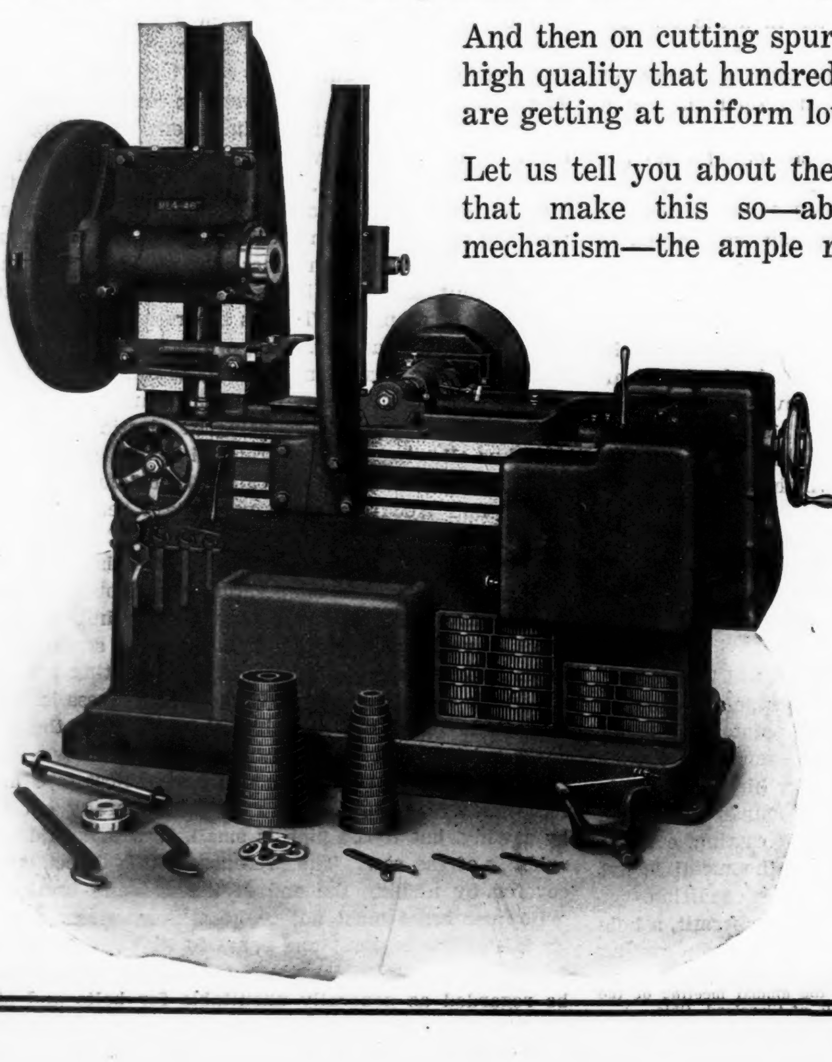
CUTTING SPROCKETS

like cutting gears is a particular job—the spacing must be right and the blank rigidly supported if the cutter is to form the teeth accurately—you must watch out for these points to get sprockets that work properly. And then good work must go hand in hand with fast production—your machines must give you both of these to keep up with the present pace of manufacturing and prove a profitable investment.

Brown & Sharpe

Automatic Gear Cutting Machines

are especially well fitted to handle the cutting of sprockets with a degree of speed and accuracy that will meet the production demands of every sprocket maker.



And then on cutting spur gears you can get the same high quality that hundreds of users of these machines are getting at uniform low costs.

Let us tell you about the features of these machines that make this so—about the positive indexing mechanism—the ample rigidity allowing rapid cutting—the convenient arrangement and control.

Our descriptive circulars give this—we want you to read them.

This is our No. 4 Automatic Gear Cutting Machine, a size well suited for ordinary sprocket requirements as well as for spur gears to 48-inches in diameter with 10-inch face.

is practically impossible to fit and tighten a bolt in such a manner that one is sure not to stress it above the initial elastic limit, at least on one side. All bolts used in flanged connections are stressed more on one side than on the other, because of the deflection of the flanges; and even under the most favorable conditions, when the connected parts are so stiff that the deflection is insignificant, brass bolts may easily be drawn up so tight that the entire cross-section at the root of the thread is stressed above the initial elastic limit. Another source of defects in brass work lies in heat-treatment by workmen unfamiliar with the properties of brass. Men accustomed to do such work on iron and steel are very likely to ruin the brass by overheating. The best insurance against trouble is to allow no brass forging to be done by men who are not experienced in this kind of work. Specifications should provide that no hot working of brass is done by those not regularly engaged in such work, and hot working should be avoided as much as possible. Brass, being very ductile, may be formed into any shape by cold working, accompanied by annealing. Large rivets must be driven hot, but flanging and other kinds of bending should be done cold. This work should be done by experienced men and in shops equipped with the necessary appliances; for instance, the flanging of circular heads should be done by pressing between dies, and in several stages, each being followed by annealing. One should not attempt to do such work on brass by hammering over a form, as is done with copper.

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

of MACHINERY, published monthly on the 1st at New York, N. Y., for October 1, 1916.

State of New York }
County of New York } ss.

Before me, a Notary Public in and for the state and county aforesaid, personally appeared Matthew J. O'Neill, who, having been duly sworn according to law, deposes and says that he is the General Manager of MACHINERY and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, The Industrial Press	140-148 Lafayette St., New York
Editor, Fred E. Rogers	" " " " "
Managing Editor, None	
Business Managers { Alexander Luchars, President	" " " " "
Business Managers { Matthew J. O'Neill, Gen'l Manager	" " " " "

2. That the owners of 1 per cent or more of the total amount of stock are:

The Industrial Press	140-148 Lafayette St., New York
Alexander Luchars	" " " " "
Matthew J. O'Neill	" " " " "
Fred E. Rogers	" " " " "
Louis Pelletier	" " " " "
Erik Oberg	" " " " "

3. That there are no bondholders, mortgagees or other security holders.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 15th day of September, 1916.

THOMAS R. WILLIAMS,

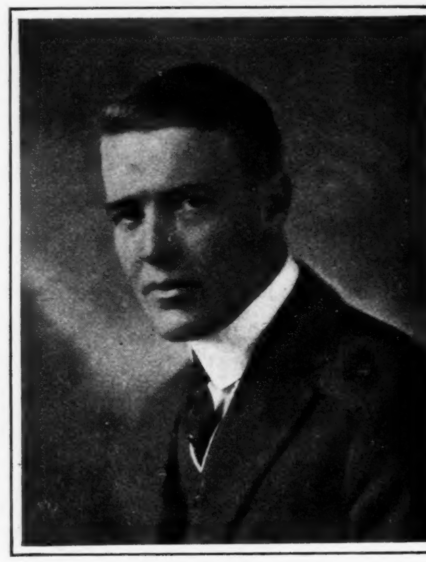
(SEAL) Notary Public, New York County, No. 254.
(My commission expires March 30, 1918.)

OBITUARIES

W. K. Millholland, president of the W. K. Millholland Machine Co., Indianapolis, Ind., died October 9, aged sixty years. Mr. Millholland had acquired a varied experience as a mechanic, salesman and manufacturer. In 1909 he organized the W. K. Millholland Machine Co., which has grown from a small beginning to a concern employing over one hundred men. He is survived by a widow and seven sons, four of whom are employed in the company.

Frederick W. Hoefer, president of the Hoefer Mfg. Co., Freeport, Ill., whose death September 28 was noted in the November number, was one of the leading manufacturers of Freeport, having been established there in business for twenty-eight years. Mr. Hoefer was an inventor of wire forming machines, spring coiling machines and other machines having original characteristics. He secured patents on spring coiling machines which were on distinct principles and which gave him control of the spring coiling machinery during the life of the patents. Some years ago the Hoefer Mfg. Co. disposed of the wire forming and spring coiling machinery, and the business was afterward devoted to the manufacture of drilling machines. His widow, two daughters and a son, Chester A. Hoefer, secretary of the company, survive him.

Edward T. Hendee, secretary of Joseph T. Ryerson & Son, Chicago, Ill., died suddenly at Minneapolis, Minn., November 12, aged thirty-six years. Mr. Hendee graduated from New York University in 1900 with the degree of B.S., and afterward received the degrees of M.E. and M.S. He also received the degree of Sc.D. at Columbia University in 1901; and from 1901 to 1902 he was assistant professor of mechanical engineering at New York University. In 1902 Mr. Hendee became associated with Joseph T. Ryerson & Son of Chicago as advertising manager, in which capacity he displayed much initiative and force. He built up and became manager of the machinery department; in 1911 he was made assistant to the president, and in 1913 assumed charge of the railway supply department of the company. He was elected secretary in 1913, and continued to fill the position up to the time of his death. Under Mr. Hendee's able leadership, both the domestic and foreign machinery business and the railway supply business for the company were very widely extended. He gave loyal and indefatigable service to his company and inspired with enthusiasm everyone with whom he came in contact. The three qualities of loyalty, energy and enthusiasm were prominent factors in his remarkable success. Mr. Hendee was married in 1907 to Miss Bessie E. Comstock. His widow and two sons survive him.



Edward T. Hendee

PERSONALS

H. T. Benham has been made manager of the advertising department of E. C. Atkins & Co., Indianapolis, Ind., succeeding T. A. Carroll, resigned.

Donald Baker, who recently went with the Williams Mfg. Co., Ltd., Montreal, Canada, has been promoted to the position of assistant superintendent.

Louis Ruthenburg has been appointed general manager of the Dayton Engineering Laboratories Co., Dayton, Ohio, succeeding W. P. Anderson, resigned.

L. S. Devos, formerly purchasing agent for R. Martens & Co., 24 State St., New York City, has joined the selling force of the Selson Engineering Co., New York City.

J. O. Smith, vice-president of the American Emery Wheel Works, Providence, R. I., has resigned. Mr. Smith has made no announcement of his plans for the future.

Roy B. Dow, formerly secretary of the Cochrane-Bly Co., Rochester, N. Y., manufacturer of cold sawing machines, is now connected with the Erdle Perforating Co., Rochester, N. Y.

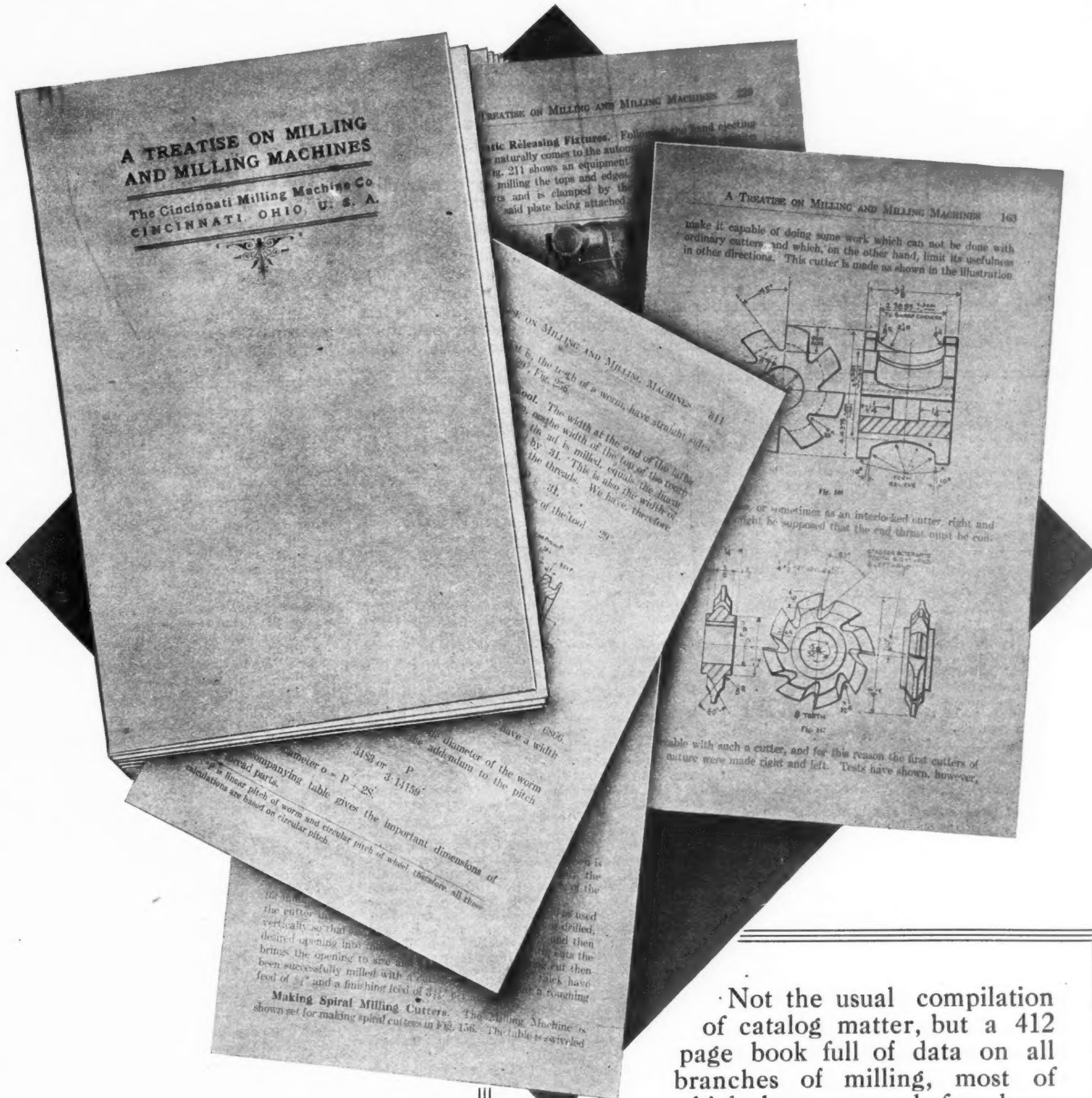
Lieut.-Col. A. H. W. J. Boom has announced the removal of the offices of the purchasing delegation, Government of the Netherlands, War Department, from the Hotel McAlpin to 50 E. 42nd St., New York City.

Carl E. Akeley of the American Museum of Natural History, New York City, has been awarded the John Scott medal and premium for the invention of the cement gun, a device for applying cement mortar by the use of compressed air.

Norman L. Warford, formerly with the powdered coal department of the Anaconda Copper Mining Co., Anaconda, Mont., has joined the Powdered Coal Engineering & Equipment Co. of Chicago, in the capacity of engineer in charge of construction.

A. H. Young, supervisor of labor and safety, Illinois Steel Co., South Chicago Works, has been appointed director of the American Museum of Safety, New York City, succeeding to the position made vacant by the recent removal of Dr. William H. Tolman.

Frederick Fisher has joined the R. E. Ellis Engineering Co., Inc., of Chicago, as vice-president and treasurer. Mr. Fisher was formerly associated with the Bucyrus Co. and has ac-



Just Off the Press—
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Cincinnati Ohio, U. S. A.

quired valuable experience in general shop practice as a chemical engineer.

John V. N. Dorr, president of the Dorr Cyanide Machinery Co., New York City, has been awarded the John Scott medal and premium by the Franklin Institute of Philadelphia for the invention of the Dorr classifier, the Dorr thickener and the Dorr agitator.

The John Fritz medal, awarded in January, 1916, to Dr. Elihu Thomson for his inventions and achievements in electrical engineering, will be presented to Dr. Thomson in Boston, Friday evening, December 8, 1916, in the Central Lecture Hall of the Massachusetts Institute of Technology.

R. W. Valls, formerly chief engineer and designer for the Shaw Electric Crane Co., Muskegon, Mich., has resigned his position, and has been made chief designer and manager for the crane department of the Champion Iron Co., Kenton, Ohio, which will place a line of electric traveling cranes on the market.

R. G. Clyne, for the past seven years mechanical engineer with the Western Cartridge Co., East Alton, Ill., has resigned, and will go into business for himself in St. Louis, Mo., designing and building special machinery. He has devoted over twenty-six years to the design of machinery used in the manufacture of cartridges.

George O. Smalley has been promoted to the position of first vice-president and general manager of the Bound Brook Oilless Bearing Co., Bound Brook, N. J., succeeding the late Leigh S. Bache. Mr. Smalley has been connected with the company for the past ten years, the last four years of which he was assistant general manager and assistant treasurer.

H. A. Runge of the Internations Commercial Corporation, 44 Whitehall St., New York City, has been elected vice-president in charge of machinery and heavy hardware. Mr. Runge was for a number of years connected with the export department of Manning, Maxwell & Moore, Inc. For the past fifteen years he has devoted his time to foreign trade, specializing on machinery, machine tools, railroad materials and sugar plantation machinery and supplies.

COMING EVENTS

December 5-8.—Annual meeting of the American Society of Mechanical Engineers in New York City. Engineering Societies' Bldg., 29 W. 39th St., headquarters. Calvin W. Rice, secretary.

January 6-13.—National Automobile Show in Grand Central Palace, New York City.

SOCIETIES, SCHOOLS AND COLLEGES

International Correspondence Schools, Scranton, Pa. "Manual of Information for Students," which is given to each student when he enrolls, its object being to inform the students on the correspondence system of education, instruction papers, correspondence, method of procedure, postal matters, how to study, and how to make the training received useful in obtaining a position.

NEW BOOKS AND PAMPHLETS

Some Graphical Solutions of Electric Railway Problems. By A. M. Buck. 36 pages, 6 by 9 inches. Illustrated. Published by the University of Illinois, Urbana, Ill., as Bulletin No. 90 of the Engineering Experiment Station. Price, 20 cents.

Anatomy of a Steel Hopper Bottom Coal Car. By George L. Fowler. Chart, 25 by 18 inches. Published by Norman W. Henley Publishing Co., New York City. Price, 25 cents.

This chart shows a diagram of a steel hopper bottom coal car and gives a reference list of all the parts which are indicated by numbers in the diagram. This list is arranged alphabetically and contains the names of 150 parts.

Plain and Ornamental Forging. By Ernst Schwarzkopf. 267 pages, 5 by 7½ inches. 228 illustrations. Published by John Wiley & Sons, Inc., New York City. Price, $1.50 net.

This work treats of the general properties of iron; forge and blacksmith tools; various practical exercises, including upsetting, offsetting, shouldering, drawing, forming, bending, welding and forging. It deals with the properties of steel, annealing, hardening and tempering, toolmaking, art forging, etc. It is designed primarily to assist the beginner to comprehend both the theory and practice of forge work through self-instruction, and contains much elementary and simple matter in the opening chapters.

Canadian Trade Index. 560 pages, 6¾ by 10 inches. Published by the Canadian Manufacturers' Association, Inc., Toronto, Canada. Price, $5.

The work is in three parts, the first part being an alphabetical list of Canadian manufacturers, giving also their branch offices, factories, export representatives, etc. The second part is the index proper, consisting of an alphabetical list of articles manufactured in Canada with the names and addresses of the makers. The third part, in French, gives the names of articles made in Canada with reference to the sections in which the names of the makers may be found. The work obviously is indispensable to those wishing a segregated list of Canadian products and manufacturers.

Automobile Welding with the Oxy-acetylene Flame. By M. Keith Dunham. 167 pages, 4 by 6 inches. 65 illustrations. Published by Norman W. Henley Publishing Co., New York City. Price, $1.

This little treatise on oxy-acetylene welding was written by a practical man who has had much experience in the use and design of oxy-acetylene apparatus. It should be useful to all classes of repair men, including machinists, blacksmiths, garage and service station men, millwrights, etc. The contents by chapter heads are as follows: Apparatus Knowledge; Shop Equipment and Initial Procedure; Cast Iron; Aluminum; Steel; Malleable Iron, Copper, Brass, Bronze; Carbon Burning and Other Uses of Oxygen and Acetylene; and How to Figure Cost of Welding. The book is of a size that is convenient to carry in the pocket or to keep in the tool chest of the repair man.

Liquid Measuring Pumps. By F. J. Schlink. 27 pages, 6 by 9 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards No. 81.

This report pertains to the accuracy of liquid measuring pumps commonly used in dispensing gasoline for use in motor cars. There are several types of measuring systems in use, the most common being the piston type, which is the same in principle as the ordinary plunger pump, equipped with stops to define the volume discharged. The principal causes of short delivery are leaks in valves or piping, formation of vapor due to excessive suction lift, or the introduction of air under the piston. Of numerous measuring systems of various types chosen at random and tested by the Bureau of Standards' inspector in a number of different cities, 70 to 80 per cent had excessive errors. Figures based on the best estimates obtainable show that in Illinois the losses to users due to short measure in gasoline are not less than $530,000 annually.

Applied Electricity for Practical Men. By Arthur J. Rowland. 375 pages, 5 by 7¼ inches. 325 illustrations. Published by McGraw-Hill Book Co., Inc., New York City. Price, $2.

The book has been in process of making during twenty years' experience of the author, who is professor of electrical engineering at the Drexel Institute in Philadelphia. It was written from the standpoint of one who puts up and operates electric circuits and apparatus, and it does not treat of problems of apparatus design. Theory is avoided except as it has direct bearing upon practical matter, the aim being to make the work of greater value to practical men who wish to obtain a working knowledge of the electrical science without burdening their minds with theory of little or no use in their daily work. The book treats of fundamental principles, electromotive force and Ohm's law, magnets and magnetic flux, direct-current dynamo (electromotive force), drum armatures and multipolar machines, electric heating, electric power, direct-current systems of distribution, direct-current motors, principles of alternating current, alternating-current transformers, polyphase-current principles, alternators, alternating-current motors, other alternating-current machinery, storage batteries, electric lights, and wiring.

Melting Aluminum Chips. By H. W. Gillett and G. M. James. 88 pages, 6 by 9 inches. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin No. 108.

This bulletin gives an account of experiments made to compare the recovery of metallic aluminum in melting down chips such as are obtained in the automobile factories in machining aluminum castings. As aluminum has sold at three times its normal price for the past year, and as a recovery of but 60 per cent of the metal in the chips is common, and a 90 per cent recovery is commercially possible, the preventable loss is of considerable magnitude. The bulletin discusses the causes of the high loss in the usual method of melting chips, and shows that the difficulty of getting the tiny globules of molten metal resulting from the fusion of the very fine chips to coalesce, when covered with a skin of oxide and dirt, is apparently the main cause for low recoveries. Two methods of melting can be successfully used to promote coalescence. In one method the chips are kept just above the fusion point and the globules made to coalesce by hand puddling, which breaks through the skin and makes the globules unite. In this method, melting is best done in an iron pot heated by oil. The other is by the use of a flux which dissolves the skin of dirt and oxide, producing clean globules which can unite. The flux suggested is 85 per cent common salt, 15 per cent fluorspar, used in large amount (20 to 30 per cent of the weight of the chips) and mixed with the chips before charging. Much higher temperatures are required by this method than by the puddling method.

Lubricating Engineers' Handbook. By John R. Battle. 333 pages, 6 by 9 inches. 114 illustrations. Published by J. B. Lippincott Co., Philadelphia, Pa. Price, $4 net.

This comprehensive reference book of data, tables and general information for the use of lubricating engineers and others concerned in the use of lubricants is a valuable contribution to engineering literature. The author declares that of all the supplies used in the operation of power plants and mills, lubricants and their practical application are the least understood, and when it is considered that not a spindle can turn without overheating and wear, the importance of lubricants may be more fully appreciated. The book treats of friction, theory of lubrication, briefly of the history of petroleum, the characteristics of petroleum and other lubricants and greases, of lubricating oil and grease tests, and includes oil data and many miscellaneous notes. Data are given on the average cost of power per horsepower year, and the lubrication of power transmission apparatus, including shafting, is taken up; also on lubricants for cutting tools and oils for quenching tools for hardening. Chapters are devoted to the lubrication of steam engines and steam turbines; oil cups, grease cups and filters; oil houses and oil-house methods; and the general forms of bearings and materials used for lining bearings. Air compressors and automobiles present special problems for the lubricating engineer, as well as coal mining machinery and Diesel engines. These are taken up in separate discussions. The work, as a whole, is thorough and comprehensive. It is profusely illustrated, and contains much valuable data useful to all classes concerned with the use of machinery and lubricants.

A Treatise on Milling and Milling Machines. 409 pages, 6 by 9 inches. 267 illustrations. Published by the Cincinnati Milling Machine Co., Cincinnati, Ohio. Price, $1.50.

This comprehensive work on milling and milling machine practice should be welcome to manufacturers and mechanics generally. Milling as a means of machining metal parts has developed broadly during the past ten years, and is generally conceded to be one of the principal methods of machining parts manufactured in quantities. The contents of the book by chapter heads follow: The Construction and Use of Milling Machines; Erection, Care and Adjustment of Milling Machines; Tool-room Millers—The Dividing Head, etc.; Setting Up the Machine; An Analysis of the Process of Milling; Milling Machine Feeds; Speeds of Milling Cutters; Stream Lubrication—Cutter and Work Cooling System; Milling Cutters—Notes on the Design and Efficiency of Modern Cutters; Cutter Sharpening; Power Required to do Milling; Various Methods of Milling; Milling Jigs and Fixtures; The Sizing and Cutting of Spur Gears; Shop Trigonometry—Bevel Gears and Their Calculation—Instructions for Cutting; Spiral Gear Cutting—Calculations, Formulas, Tables, etc.; Worm-gearing—Calculations and Methods of Cutting; Continued Fractions and Their Application to Shop Problems—Angular Indexing; Change-gears for Cutting Spirals; Cams—Tables for Setting the Milling Machine for Milling Spiral Cams; Tables of Natural Trigonometric Functions. The book is profusely illustrated with halftone and line illustrations, and well printed on good quality paper. Mathematical tables and data on gear cutting are included, making it a most valuable reference book for the mechanic concerned with milling practice in any way.

NEW CATALOGUES AND CIRCULARS

Modern Tool Co., 2nd and State Sts., Erie, Pa. Bulletin 34 on "Modern" adjustable collapsing taps.

Chicago Pneumatic Tool Co., Chicago, Ill. Bulletin 34-X, describing and illustrating "Giant" gas engines.

Kelly Reamer Co., Cleveland, Ohio. Catalogue G, treating of Kelly reamers with adjustable high-speed blades.

General Electric Co., Schenectady, N. Y. Bulletins 46101-A, 46103-A and 46104-A, descriptive of General Electric Type P, Type M, and Type G demand meters, respectively.

Rodney Hunt Machine Co., Orange, Mass. Catalogue 30 of Hunt water controlling apparatus, comprising flumes, penstocks, standpipes, relief valves, hoists and stands, trash racks, etc.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Circular containing outline of shop courses in blueprint reading, shop drawing, shop mathematics, shop mechanics and practical electricity.

Wahlstrom Tool Co., 5520 Second Ave., Brooklyn, N. Y. Catalogue of Wahlstrom automatic drill chucks with positive drive. These chucks are made in two styles for straight and taper shank tools, respectively.

Wood & Safford Machine Works, 109-111 S. 6th St., Great Falls, Mont. Circular of the "Perfection" cylinder grinder which may be used on engine lathes for grinding the bore of automobile cylinders and similar work.

Southwark Foundry & Machine Co., Philadelphia, Pa. Circulars descriptive of Southwark universal flue welder, washer press, gross press for reclaiming scrap material and repairing steel cars, and hydraulic extrusion presses.

National X-Ray Reflector Co., 235 W. Jackson Blvd., Chicago, Ill., is issuing a series of detail plates illustrating installations of indirect lighting systems in banks, theaters, moving picture houses and other public buildings.

Coats Machine Tool Co., Inc., 30 Church St., New York City. Catalogue descriptive of the Coats duplex hacksaw machine which is equipped with two blades, thus doubling the production. This machine takes 270 cutting strokes per minute in mild steel.

Link-Belt Co., Chicago, Ill., has issued two new booklets describing the Link-Belt coal and ashes handling machinery which was recently installed for the Victor Talking Machine Co. at Camden, N. J., and for the W. H. Grundy Co. at Bristol, Pa., respectively.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin 130, treating of the lubrication of pneumatic tools. The pamphlet outlines the advantages of "Airoilene" grease and oil for this purpose, and illustrates Chicago automatic oilers and "Little Giant" grease machines.

Link-Belt Co., 39th St. and Stewart Ave., Chicago, Ill. Bulletin 282, entitled "Link-Belt Silent Chain Transmitting Power in the Dye-making Industry," illustrating Link-Belt silent chain drive installed in the plant of the Schoellkopf Aniline & Chemical Works, Inc., Buffalo, N. Y.

Moore & White Co., 2707-2737 N. 15th St., Philadelphia, Pa. Catalogue devoted to Moore & White high-speed friction clutches, containing a general description and giving dimensions and specifications of the various sizes. The catalogue also contains price lists of cast-iron pulleys made by this company.

Tate-Jones & Co., Inc., Pittsburg, Pa. Circular 149-A, treating of large and medium sized forging furnaces for heating billets for large hammer and press work and for medium sized forging work. Circular 150, illustrating small forging furnaces for forging machines, drop-hammers, forging presses, etc.

Ingersoll-Rand Co., 11 Broadway, New York City. Form 3180 of Class ER-1 power-driven, single-stage, straight-line air compressors, which are built in sizes with from 6- to 12-inch stroke and piston displacement capacities of 52 to 955 cubic feet per minute. These compressors are equipped with the Ingersoll-Rogler type of air valve.

Gisholt Machine Co., 1209 E. Washington Ave., Madison, Wis. Circular advertising Gisholt solid-adjustable reamers, which combine the advantages of both the solid and the adjustable types. This circular gives tables of prices and dimensions for shell reamers, hand reamers and taper shank chucking reamers with high-speed steel blades.

Vanadium-Alloys Steel Co., Pittsburg, Pa. New pamphlet on "Vasco" vanadium, which is an alloy steel for tools and all purposes where toughness and durability are particularly required. The pamphlet treats of alloy steels in general and their uses, and describes the various types of "Vasco" vanadium steel. A complete list of carbon steel extras is also included.

Winfield Electric Welding Machine Co., Warren, Ohio, is bringing out a booklet describing the various electric welding processes. The book shows installations of Winfield electric welding machines in different parts of the United States, and gives information and data in connection with spot- and butt-welding that will be of interest to manufacturers in general.

Ingersoll-Rand Co., 11 Broadway, New York City. Form 8311, treating of "Little David" pneumatic riveting hammers of the inside trigger pattern. These hammers are made in six sizes, the dimensions and specifications of which are tabulated in the catalogue. The important feature of this tool is the rivet set retainer designed to meet the regulations and requirements of the safety laws of the various states.

Watson-Stillman Co., 192 Fulton St., New York City. Catalogue 94, describing the Watson-Stillman line of hydraulic valves and fittings. Dimensions and prices are given for hydraulic pipes, hydraulic nipples, flexible metallic pipe and tubing, bushings and plugs, unions, couplings, swivels, fittings, safety valves, check valves, stop valves, operating valves, by-pass valves, regulating valves and special valves. Tables of equivalent internal sectional areas of pipes are included.

Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa. Catalogue 51, treating of cold saw cutting-off machines. The latest designs and sizes of Newton cold saw cutting-off machines are described, as well as saw blade sharpening machines, milling machines, slotting machines, rotary planing machines, keyseat milling and cottering machines, cylinder boring machines, rail drilling machines and locomotive rod boring machines. The catalogue also illustrates cold saw cutting-off machines in use in various plants.

Bellevue Industrial Furnace Co., Detroit, Mich. Catalogue 3 of Bellevue furnaces for heat-treating steel. The catalogue lists and illustrates stock sizes of Bellevue furnaces and accessories designed to supply standard equipment for all methods of metal heat-treating. These furnaces are adapted for oil or gas, according to the class of work for which they are intended. Furnaces for heating, casehardening, annealing and tempering in various styles and sizes are shown, as well as enameling ovens, kilns for testing and experimental work, fire-brick, burners, blowers, thermometers, air pressure gages and pyrometers.

Van Dorn & Dutton Co., Cleveland, Ohio, is issuing a booklet entitled "Facts About Gears" that contains suggestions as to the selection of materials for certain qualities, heat-treatment and specifications. There are also included tabulated data on gearing terms, drawings and specification formulas for every type of gearing. The contents treat of: different types of gears; facts about gears; gearing terms; how to order gears of all kinds; spur gear specifications; bevel and miter gear specifications; worms and worm-gears; sprocket specifications; Lewis' rule for strength of gear teeth; diametral pitch formulas and table; circular pitch formulas and table; decimal equivalents of parts of an inch and of fractions of millimeters; metric pitch-module; standard keyways; comparative sizes of gear teeth; weights of round steel; weights of metals; and circumferences and areas of circles. The book should be of considerable value to all gear users and may be obtained free upon request.

Star Corundum Wheel Co., Detroit, Mich. Catalogue of Star grinding wheels which are made by three distinct processes, namely, vitrified, silicate and elastic. The catalogue gives the uses of these three classes of wheels, outlines general safety requirements and gives grinding wheel speeds. Price lists are given for wheels for various standard types of grinding machines, as well as for special machines. The book also gives information on testing and inspection, selection of grades for different work, and tables of decimal equivalents, weights of wheels, etc. The Star Corundum Wheel Co. is issuing with its catalogue of grinding wheels a pamphlet containing a safety code for the use and care of abrasive wheels, which is based on the report of a special committee appointed by the National Machine Tool Builders' Association to consider safety in connection with abrasive wheels and grinding machines and a tentative report of a special committee appointed by the state of Pennsylvania to draft laws pertaining to grinding and polishing.

TRADE NOTES

Grayson Tool & Mfg. Co. has moved from Indianapolis, Ind., to Charleston, W. Va.

American Machine & Foundry Co. has moved from 346 Carroll St. to 5520 Second Ave., Brooklyn, N. Y.

Blomquist-Eck Machine & Mfg. Co., 203 St. Clair Ave., N.E., Cleveland, Ohio, has changed its name to Blomquist-Eck Machine Co.

Wausau Abrasives Co., Chicago, Ill., has established headquarters at 118 S. Clinton St., where a complete stock of goods manufactured by the company will be kept.

Bullard Machine Tool Co., Bridgeport, Conn., has insured its men and women employes, aggregating about one thousand, for various sums amounting to a total of about $500,000.

Adams-Bagnall Electric Co., Cleveland, Ohio, is installing a porcelain enameling plant to improve the quality and service of its line of porcelain enameled reflectors for industrial lighting.

C. W. Burton Griffiths & Co. of London, importers of American machine tools, who formerly had an office at 2732 Grand Central Terminal Bldg., New York City, have moved to 110 W. 40th St.

Leland-Gifford Co., Worcester, Mass., manufacturer of drilling machines, has opened an office in Room 418, Singer Bldg., 149 Broadway, New York City, in charge of Walter F. Henly, formerly with the Fairbanks Co.

Doehler Die-Casting Co., Court and Ninth Sts., Brooklyn, N. Y., has let the contract to the Turner Construction Co. for a steel and concrete addition to its Brooklyn factory, 50 by 100 feet, seven stories high, costing approximately $150,000.

Ready Tool Co., Bridgeport, Conn., has moved into its new plant at the corner of Iranistan and Railroad Aves., and is installing new machinery and equipping the plant with an electric welding machine for welding high-speed steel and stellite.

Biggs-Watterson Co., Cleveland, Ohio, has removed its office from the Hippodrome Bldg. to Rooms 721-722 of the Guardian Bldg., Cleveland. The company has also opened offices at 412 Traction Bldg., Cincinnati, Ohio; 2613 Dime Bank Bldg., Detroit, Mich.; and in Toledo, Ohio.

Patterson, Gottfried & Hunter, Inc., New York City, dealer in machinery, metals, hardware, tools and supplies, having stores at 147-151 Lafayette St. and 211-215 Center St., has opened a new store at 170 Fulton St., between Church St. and Broadway, for the convenience of downtown customers.

Charles Churchill & Co., Ltd., London, England, have issued a warning that an impostor is traveling in the United States and attempting to borrow money on the strength of his alleged relationship to one of the directors of the company. He tells the usual story about having lost his money and having become stranded.

Champion Iron Co., Kenton, Ohio, will place upon the market a full line of electric traveling cranes, and the Biggs-Watterson Co., 721-722 Guardian Bldg., Cleveland, Ohio, will act as exclusive selling agent. The Champion Iron Co. has secured the services of R. W. Valls, formerly designer and chief engineer of the Shaw Electric Crane Co., Muskegon, Mich., as chief designer and manager of the crane department.

Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio, has received an order from the Goodyear Tire & Rubber Co., Akron, Ohio, for seventy hydraulic hot plate presses, which will be used for vulcanizing purposes in the Goodyear rubber plant in Akron. They will be operated by hydraulic pump and accumulator systems already installed. The presses are all of one design and have a pressure capacity of 115 tons each.

S. K. F. Ball Bearing Co., Hartford, Conn., has been awarded the contract for the self-aligning ball bearing hangers and pillow blocks specified for use throughout the new plant of the Courtenay Mfg. Co. of Newry, S. C. The order is said to be the largest ever placed in the United States for ball bearing hangers and pillow blocks to be installed in one mill. The sizes range from bearings for 6-inch shafts down to 1 11/16-inch shafts.

Becker Milling Machine Co., Hyde Park, Mass., states that the report of the sale of the company to the Manufacturers Co. of Boston is misleading. The deal was the sale by Eugene N. Foss, president, of his stock in the company to Robert F. Herrick; the price alleged to have been paid is $2,000,000. The Becker Milling Machine Co. will continue the same as usual, and additions will be made to the plant at an early date. There will be no change in the organization or the policy of the company.

Modern Tool Co., 2nd and State Sts., Erie, Pa., manufacturer of grinding machines and threading tools, has appointed Leo C. Steinle direct representative in France, with offices at Paris and Lyons. Mr. Steinle is actively connected with the Steinle Turret Machine Co. of Madison, Wis., whose interests he is also caring for abroad. R. H. Wood has been made manager of the company's district office, 32 N. Clinton St., Chicago, Ill. Mr. Wood was for a number of years connected with the Buffalo office of the Warner & Swasey Co.

N. & W. Tool Co., 284 Asylum St., Hartford, Conn., was organized by A. T. Nielsen and A. E. Wilson early in this year to specialize in punch and die work. The demand for general tool work became so great, however, that the concern has branched out. It is equipped to do almost everything required in the general line of tools, jigs, fixtures and die work. Mr. Nielsen acquired his experience with the Moller, Jorkumsen Co. at Horsens, Denmark, and Mr. Wilson was formerly with the Pratt & Whitney Co.

R. E. Ellis Engineering Co., Inc., 549 Washington Blvd., Chicago, Ill., has secured the representation of the Hannifin Mfg. Co., maker of air-operated chucks and equipment; Murchey Machine & Tool Co., maker of automatic die-heads and collapsing taps; Kelly Reamer Co., maker of reamers and boring-bars; Tate-Jones & Co., Inc., maker of oil and gas burning furnaces; Bury Compressor Co., maker of air compressors; Hoefer Mfg. Co., maker of auxiliary multiple-spindle drill heads; Standard Electric Tool Co., maker of portable electric drills and grinders; Acme Die-Casting Corporation, maker of die-castings in aluminum and standard alloys.

Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa., announces that a group of bankers has acquired a controlling interest in the company. These bankers also own a substantial interest in the S. K. F. Ball Bearing Co. of Hartford, Conn., but the two companies will be operated independently of each other. The former policy of the Hess-Bright Mfg. Co. will be continued except that its manufacturing facilities will be increased somewhat to meet the constantly growing demand for its product. F. E. Bright retires from active participation in the company's affairs, but remains chairman of the board. Aside from this change, the organization remains as before.

American Committee, Lyons Sample Fair, Lyons, France, has issued a booklet giving rates and other essential data relating to the Lyons Sample Fair, which will be held at Lyons, France, March 1 to 15, 1917. The aim and object of the various committees is to bring together at the next annual Lyons Fair a large and representative gathering of manufacturers and wholesale buyers from countries all over the world, with the exception of the enemies of France; this will be an opportunity for placing American goods before buyers from Europe, South America and the Orient. Those who are interested can obtain further information from the National Headquarters, 1790 Broadway, New York City.

Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio, has found it necessary to make immediate plant and equipment extensions owing to the demand for its hydraulic presses, pumps, valves, accumulators and intensifiers. An addition 60 by 100 feet will be made to the machine shop to relieve the crowded condition, and considerable new equipment will be required for the addition, including a twenty-ton electric traveling crane, large motor-driven horizontal boring mill, and heavy-duty motor-driven planer. A 20-foot extension will be added to the power house building, and some new power plant equipment will be installed. The main stock-room will be extended and another story added, and a new structural shop about 50 by 60 feet will be erected. The plans also provide for an extension of the present erecting shop building measuring 47 by 130 feet. Brick and concrete construction with steel superstructure will be employed throughout.

George Schow, Ovre Slotsgate 7, Christiania, Norway, has consolidated his Russian and Scandinavian interests with A/S Netco, Northern Engineering & Trading Co. The capital has been increased to 1,500,000 crowns in order to take care of the growing business. The company's headquarters will be, as before, at Christiania; the president of the company is Halfdan Steen-Hansen, and F. Morch-Reiersen, Jr., is the managing director of the Norwegian office. The company has opened branch offices in Petrograd, Russia, in charge of Fedor Andrejevitsch Bystrom; in Moscow and Samara, Russia, in charge of Kort Kopke; and also in Stockholm, Sweden, with Captain Erik Cronvall as the managing director. Branch offices will be opened in Copenhagen, Denmark, in the near future. The New York office is in charge of Ingvar Tokstad, president of the Normanna Co., Inc., who is also the secretary of the Norwegian-American Chamber of Commerce. Mr. Schow is general manager of agencies for all the countries referred to, and their work will be under his personal supervision.